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# Annotated Bibliography of Training Technologies and Methods for Teaching the Use of Advanced Technology

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Armored Forces Research Unit

U.S. Army Research Institute for the Behavioral and Social Sciences

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University of Louisville

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## Annotated Bibliography of Training Technologies and Methods for Teaching the Use of Advanced Technology

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## FOREWORD

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The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) is dedicated to helping U.S. Army commanders and trainers understand the most efficient procedures for training and maintaining a proficient force. This goal has become increasingly important as training resources have become more limited. Army training developers, commanders, and trainers need to know the factors that affect soldiers' acquisition and retention of job-related skills. This research product provides such information in relationship to training for the future.

The work described in this research product is a part of the Armored Forces Research Unit's work program under the Research Task entitled Technologies for Advanced Mounted Warfare Training (TANTAMOUNT). The information contained in this research product will be made available to commanders, trainers, and civilian training developers at the U.S. Army Armor Center and School at Fort Knox.

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ANNOTATED BIBLIOGRAPHY OF TRAINING TECHNOLOGIES AND METHODS FOR  
TEACHING THE USE OF ADVANCED TECHNOLOGY

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# Annotated Bibliography of Training Technologies and Methods for Teaching the Use of Advanced Technology

## Introduction

### Overview

The anticipated incorporation of computer-based information systems into the U.S. Army's future armored vehicles will revolutionize the battlefield. The anticipated improvements include enhanced navigation, decreased fratricide, and increased synchronization (Funk, 1994). Historically, forces with superior information, not superior numbers, have been victorious (West, 1994). However, these improvements will only be realized if soldiers are adequately trained to use the new technologies. After all, it is well-trained and motivated soldiers, not technology, that win wars (Slear, 1994; Sullivan & Dubik, 1993). As recently demonstrated at the National Training Center (NTC), the installation of sophisticated information systems does not guarantee success (Grimes, 1994). Adequate training for the users of such systems is an important and often overlooked aspect of unit readiness. Providing this training is one of the biggest challenges facing the U.S. Army today (Smith, 1994).

As the complexity of information systems increases, training must be highly adapted to the specific context of the system and user. Existing evidence suggests that traditional training methods (classroom-based lectures and books) will not prepare future soldiers for the use of complex command and control technology (Gorman, 1986 [A16]; Löttscher, 1994 [A24]). Indeed, some authors have expressed concern that future soldiers will be unable to maximize the use of technological innovations due to insufficient training (e.g., Dempsey, 1994). Therefore, new training methods and technologies will need to be exploited to meet the Army's future training requirements.

### Research Objectives

This annotated bibliography surveys current literature for information on newly-available training methods and technologies. Many methodologies and technologies for training computer-related skills are available; determining which are the most effective and promising will significantly improve the efforts to modernize soldier training. In addition, this report potentially can assist future research efforts by providing a base of information from which researchers can construct in-depth training analyses and build training programs.

## Sources

To accomplish the goals set forth in the "Research Objectives," a thorough search of recent training methods and technologies was conducted. The databases that were searched consisted of: PsycLIT, Educational Resources Information Center (ERIC), Dialog, InSpec, National Technical Information Service (NTIS), Aerospace Database, and Computer Database.

The compiled articles included technical reports from various military agencies, articles in technical and scholarly journals, trade journal articles, conference presentations, and magazine articles. To some extent, articles that would normally not be read by Army psychologists and trainers were selected to assist these individuals in learning from the experiences of their counterparts in other fields. Since training technology (especially computer-based training technology) advances rapidly, only recently published articles were selected in an effort to present the most current information available.

## Report Organization

The articles in this bibliography are divided into three general areas representing the disciplines from which they originate: military, educational, and business training (Appendixes A, B, and C, respectively). Within each appendix, articles are listed alphabetically by the primary author's last name. In addition, there is a table at the end of each appendix that summarizes various training techniques recommended by each author. The remaining two appendixes contain an acronym list and a subject index (Appendixes D and E, respectively).

## Major Findings

Despite the diversity of the documents, the overall findings of this literature review are remarkably consistent. The introduction of technology such as the television, the videotape player, and the computer into the classroom has allowed instructors to change the very nature of their instruction. Students are no longer passive recipients of information; they are now active participants and they learn by doing tasks in hands-on environments. According to this new classroom paradigm or model, information is actively acquired during the completion of real-world tasks, not by reading about the tasks or watching someone else perform them. Computers have facilitated this change by providing realistic task simulations, personalized and self-paced instruction, and immediate feedback. In most cases, the computer asks periodic questions that assess the student's current knowledge level. Based upon the student's answers, the computer can alter the pace and direction of learning, thus fine-

tuning the instructional presentations to the student's abilities and preferences.

The majority of articles summarized herein agree on several general issues:

1. The computer is the most significant new training tool available. It has changed the structure of teaching and has redefined the roles of the teacher and student. It also holds the most potential for expansion, growth, and improvement in the future.

2. Simple computerization of existing training methods will not fully exploit the computer's training potential. For example, when television and video tapes were first used in training, an open instructional manual was not presented on the screen for the learner to read. Doing so would simply repeat the older training methods on new technology and not fully exploit the video medium. Therefore, the overall design of training programs and packages will need to be modified to maximize the computer's instructional potential.

3. The role of the student has evolved from a passive receiver of knowledge to an active collector of knowledge who learns by doing, not by reading about doing or watching others do. By the same token, the teacher's role in the modern classroom has changed from a fact-spewing lecturer to a facilitator that provides information-rich opportunities and environments.

4. Computers have forced training developers to follow strict development guidelines. Thus, the overall quality and effectiveness of training programs has improved.

5. We have only begun to realize how the computer can assist in human learning. More research is necessary to fully benefit from computer-based training.

At a more basic level, however, there is debate. In addition to studying how to teach students, the training industry is currently debating about what to teach trainees. To understand this debate, a distinction between knowledge training and performance training is necessary. Knowledge training provides students with a large amount of generalized information related to a topic or task. This knowledge may or may not be used to perform the task (thus the nickname for this training: just-in-case training). Performance training, however, attempts to teach specific problem solving strategies and information related only to the target task. Information that is not immediately required for task performance is not taught.

Optimally, this type of training teaches as little extra information as possible and the instruction occurs just before it is needed (thus the nickname for this training: just-in-time training). Some performance training systems have become Performance Support Systems (PSS) that are actually used during task performance rather than before. Therefore, performance training is effective when the task is very structured and predictable.

A debate is occurring in the instructional development community when deciding between these two types of training. The trainer is presented with a tradeoff: fast, efficient, task-specific workers versus well-educated, adaptable, thinking workers. The best answer to this dilemma is most probably a balance between the two types of training, with the specific balance determined by task and human variables. However, there is currently no agreement on how to achieve this optimal balance. The solution to this debate will be very important in future training as training budgets shrink and information technology becomes more complex.

Collectively, these documents begin to illuminate the form of future training: highly sophisticated, adaptable to the user's needs, available at any time and place, but still not perfectly understood or implemented.

#### Limitations of Findings

Apart from a few notable exceptions (e.g., Finley & Sanders, 1994 [A11]; Halff, 1994 [A18]; Norton, Gonzalez, Gomez, Kline, & Regian, 1995 [A31]), most of the conclusions in the articles are based upon the subjective opinion of the author(s) or user ratings of the training technology or methodology. Very few authors report the findings of scientific, quantitative evaluations that objectively determine the utility of a specific training methodology or device. Without such scientific analysis, the success or failure of training technologies and methodologies cannot be fully understood. This general lack of scientific validation is a disturbing trend in the training industry, as noted by Rolfe, Cook, and Durose (1986): "...hard, objective and quantitative data on the effectiveness of training devices is notoriously scarce." More objective evaluations of training systems are needed before a full understanding of their impact and potential can be assessed. It is also important to realize that the training methods and technologies discussed in the documents may not work for all situations and applications. Because of the qualitative basis of most of these documents, they are context specific and their results cannot be generalized to other situations.

However, these documents are not without value. In many cases, they represent case histories and personal accounts of the use of various training systems. These personal experiences, while not quantitatively measured, do come from training experts who are sensitive to their students' performance. Through these articles, we can begin to note which training technologies and methodologies are successful. Thus, these articles can point future research at the more promising technologies and methodologies.

## Discussion and Conclusions

### Major Conclusions

As indicated by the articles summarized here, the training industry has been revolutionized by the application of the computer to education and training. As research continues, computers improve, and new technologies such as virtual reality (VR) develop, the ability to teach and learn will grow dramatically. Computer-based training is the ideal instructional format for the Army due to its flexibility, power, ability to teach complex tasks, and potential for growth.

### Directions for Future Research

In the near future, technologies such as desktop teleconferencing and VR will mature and become less expensive. Initial attempts to apply these technologies to education and training have begun, and their potential is incredible. For example, VR will allow students to travel to other locations and time periods to study historical events, remote locations, and fantasy worlds. It will also allow the safe practice of important and dangerous procedures such as medical surgery or military battles (as demonstrated by Simulation Network (SIMNET)). Desktop teleconferencing will allow full-motion video and audio communication between people all over the world, preventing costly (and sometimes dangerous) travel while providing a forum for information exchange and learning. However, no matter how realistic future simulations become, there will always be a need for live training in addition to virtual simulations. The appropriate mix of simulation and live training will continue to be a viable research topic.



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## Appendix A

### Annotated Bibliography of Military Articles

1. Alexander, D. (1994). Getting to grips with virtual reality. Military Simulation and Training, 1, 22-27.

"Virtual Reality [VR] can be defined as a simulation technology enabling users to immerse themselves to varying degrees in an artificial environment and to interact with objects in that environment." Virtual Reality hardware consists of three major components: the head-mounted display (which typically includes earphones), the input device (e.g., datagloves, spaceball, mouse, keyboard), and the computer which processes the user's inputs and the system's outputs. The realism of experiences in VR can be described by the amount of immersion and interaction enabled by the technology. Virtual Reality is being developed for a wide variety of uses including training, development simulation, and direct command and control of systems. Specific uses within all branches of the armed services are discussed. The author predicts that VR will come of age this decade because it has become cost-effective, is an enhancement of existing technology, and it supports cross-platform diversity. One potential drawback to VR is simulator sickness, the cause and prevention of which are currently being studied.

2. Bailey, M. J., & Tierney, D. (1994). Defining the user's training technology needs: The Army's experience. Proceedings of the Interservice/Industry Training Systems and Education Conference, 16, paper 1-10.

The development of new training technologies is advancing at an unprecedented rate. User acceptance of these new systems often is related to how well the technology fills the user's needs. Total Quality Management (TQM) is recommended as a way to ensure that the user's needs are met. In TQM, the student is described as the "customer" and Research and Development (R&D) staffs as the supplier of a product. "By understanding the customer's needs, the research investment can be focused on meeting those needs. Assumptions and guesses about customer needs must be replaced by direct knowledge based on close interaction." From this viewpoint, the acceptance and use of technology becomes a management issue. The authors, who are psychologists at the U.S. Army Training and Doctrine Command (TRADOC), have implemented the TQM model in the Training Research and Development Action Plan (TRADAP). The TRADAP has highlighted technologies and methodologies that require more research and has subsequently encouraged research in these needed areas. Lessons learned from this implementation are: (a) make

simulation and training planning part of the organization's strategic planning process, (b) make simulation and training requirements explicit, (c) plan for technology transfer, and (d) form partnerships with other R&D customers. The authors conclude that if the customer (technology user) plays a significant role in the development and application of training technology, the technology will have a higher acceptance rating and will be used to its full potential.

3. Bishop, G. (1992). Digital Bridges. Unpublished manuscript.

This article begins with several future scenarios in which soldiers access on-line information and training aids through various information systems from various locations. The author then argues that these scenarios could become reality if Fort Knox installs several fiber optic local area networks (LAN) and if the Armor School develops a similar wide area network (WAN). The WAN would connect the LANs, providing an enormous amount of information to many people. Foreseen capabilities include: desktop videoconferencing, electronic mail (e-mail), compact disc (CD) quality audio and video, voice mail, and classroom presentations.

4. C' de Baca, G. (1993, Winter). HITTING the target: Latest in training technology. Army Trainer Magazine, 13(2), 15, 56.

At various times in the past, one of two basic training strategies was implemented: soldiers were either taught basic skills or, more recently, task-specific skills. The selection of either strategy partially depends on the economic climate of the time. Due to the current budget restrictions, the author argues that basic skills once again should be taught. More specifically, the High Transfer Training (HITT) approach to training is advocated. High Transfer Training is a combination of both generic and task-specific training. In other words, HITT procedures emphasize both general knowledge and job-specific skills required to perform the job. Through this dual emphasis, HITT can focus on teaching basic skills and knowledge needed to operate several similar devices instead of training one specific piece of equipment or task. "Tests show that the combined features of HITT result in a trained soldier with a high level of confidence, capable of transferring newly acquired skills and knowledge to other similar systems without the in-depth training previously required."

5. Chenvert, J. D. (1994). Interfacing interactive electronic technical manuals with interactive courseware. Proceedings of the Interservice/Industry Training Systems and Education Conference, 16, paper 2-1.

An Interactive Electronic Technical Manual (IETM) was created to provide support for a computer-based Interactive Courseware (ICW) training system that trains procedure-based maintenance. The IETM was designed for synchronized and simultaneous on-screen use with the ICW. The IETM provides the learner with large amounts of topic-specific information on demand. Implementation problems encountered during the integration of the IETM and ICW centered on preventing uncontrolled free-play in the IETM, which could distract the student from the structured training program. The combination of computer-based training and electronic text is "...a natural evolutionary step in the procession towards a paperless operating environment." The authors conclude that an IETM can significantly improve ICW use, but no quantitative analysis is reported.

6. Dorr, R. F. (1994, July). Smarter troops for a smaller force. Air Force Magazine, 77(7), 38-43.

This article describes recent changes made to the U.S. Air Force training programs by the Air Education Training Command (AETC). These programs now emphasize more formal education rather than on-the-job training and are designed to improve general knowledge and problem solving skills. Newly-trained soldiers will arrive from training schools ready to perform specific task duties. The new training structure includes training on currently fielded systems instead of older, generic trainers. In addition, periodic retraining and instruction will occur to keep personnel up-to-date on new technology throughout their career in the military. This continuing education will also be linked to promotions. In addition, a new emphasis has been placed on joint training, not only for maintenance training but also for pilots and vehicle crews. These proposed changes in soldier training are a major change in some cases, but all are required to maintain a well-trained force.

7. ECC International Corp. (1995). The electronic training classroom [Videotape].

This promotional videotape argues that traditional classroom training is no longer effective: "The greater the complexity [of the task to be learned], the less chance that traditional training methods will suffice." Several factors contribute to the ineffectiveness of the instructor-led classroom: the instructor is the only source of information, the instructor's workload is often high, training materials are not flexible, and students may avoid classroom interaction due to shyness or intimidation. Instead, computer-based training (CBT) is suggested as a superior alternative. The advantages of CBT include: self-paced instruction, standardized instruction, on-line help

and remediation, criterion referenced instruction, on-demand availability, results-oriented teaching strategies, automated record keeping, and cost effectiveness. No empirical comparisons of traditional classrooms and CBT are mentioned.

8. Edwards, A. F. (1993, Winter). Total Army teamwork digitizes the field artillery battlefield. Army Trainer Magazine, 13(2), 26-31.

This article describes the initial stages of digitizing Army National Guard (ARNG) field artillery (FA) units through the fielding of the Initial Fire Support Automated System (IFSAS). The first units to receive IFSAS used it during their annual training at Fort Pickett, Virginia. The new equipment training (NET) team from the U.S. Army Communications and Electronics Command (CECOM) developed an instructional program for the new system in four months. This training program was developed concurrently with the development and operational testing of the IFSAS. Lessons learned from the initial fielding and training of the system are discussed. The system will be fielded to all ARNG FA units by the end of 1995.

9. Edwards, A. F. (1994, Summer). High-tech training in the high desert. Army Trainer Magazine, 13(4) 24-33.

The Advanced Warfighter Experiment (AWE), held at the National Training Center (NTC) in the California desert, was a field test of several prototype digital systems. Active duty soldiers with the new equipment fought in simulated battles against the opposing forces (OPFOR) of the NTC. Foot soldiers tested the digitized dismounted soldier system, which consists of a global positioning system, helmet-mounted display, and digital video camera. Tankers used the Intervehicular Information System (IVIS), which allows them to send and receive digital communications and navigate with computer-based maps. Medical crews evaluated a telemedicine system, which allows doctors to see wounded soldiers via video camera and prescribe first aid. Drivers of the Bradley Fighting Vehicle evaluated an enhanced dashboard that includes digital navigation displays. Artillery units evaluated the Paladin, a very mobile, digitized artillery piece. "Losses were typical, but the digitized operation yielded positive results: It showed the tremendous potential of digital battlefields, especially in terms of moving information faster and more accurately." In an interview, an Armor trainer said: "We have a two-fold challenge. First, we must strike the correct balance between simulation-based training and actual field training against a well-trained opposing force. Second, our digital and information systems must be no more difficult to use

than our current, conventional systems." The trainer also said that there are three aspects of training that are most important: (a) basic soldiering skills must be maintained, (b) soldiers must be well trained to use the digital equipment, and (c) soldiers must know how to apply the digital systems to perform tasks. As for the equipment that was evaluated, the same trainer said, "Some equipment worked exceptionally well; other equipment clearly needs improvement." Training requirements and doctrine will be written according to the outcomes of the AWE. Through the AWE, active duty soldiers have been able to influence the design, training, and use of future digital systems.

10. Ellertson, J. W., & Kloecker, R. (1994, May). The challenge of joint forces training in USEUCOM. Military Review, 74(5), 13-23.

After the unqualified success of Operation Desert Storm, it is obvious that US military forces are most effective when all branches (Army, Navy, Air Force, and Marines) operate together (jointly). Future operations in Europe most likely will be peacemaking and peacekeeping operations that arise with little warning. Each situation will be unique, thus requiring the formation of a specialized joint force on a case-by-case basis. Three important tasks are vital to the success of joint operations: (a) determining the correct mixture of forces depending upon each branch's capabilities, (b) establishing a successful command structure, and (c) transferring control to the joint task force's commanders. More specific joint training objectives are: (a) orient commanders to joint operations, (b) define and practice procedures that will create the joint force, (c) practice variations of the most probable scenario in which the joint force would be created, (d) improve synchronization of joint forces, and (e) allow joint training to also benefit other military activities (e.g., the distribution of training responsibilities). Shrinking budgets and reduced force size and strength have placed additional importance on efficient training programs. Technology has played a significant role in joint training. "Computer-assisted exercises (CAXs) play an increasingly vital role as ...[the] joint force training program moves forward. They are important alternatives to unwieldy and expensive field exercises."

11. Finley, D. L., & Sanders, M. G. (1994). High transfer training (HITT): Instruction development procedures and implementation strategies. Proceedings of the Interservice/Industry Training Systems and Education Conference, 16, paper 2-3.

To improve soldier operation of a wide variety of devices, the Army has developed generic training, which teaches the

"basics" of the target class of devices. Generic training, however, has no specific development procedures, no standard form, and its success is largely unknown. Another training strategy, the Systems Approach to Training (SAT), breaks the performance of a task into its principal components and attempts to train the skills needed to perform these subtasks. However, SAT also suffers from a lack of implementation procedures. High Transfer Training (HITT) offers a solution. The objectives of the HITT methodology are to provide more systematic, standardized, and precise development and implementation of generic training, yielding improved transfer. Students are taught: (a) similarities exist between many types of equipment, (b) procedures to identify these similarities, (c) soldiers not specifically trained to use an item may still be able to perform the necessary task, and (d) by utilizing the available tools, the task can be performed. To further improve transfer of training, four additional strategies are used during HITT: (a) training on multiple equipment types and configurations, (b) allowing students to interact and assist one another, (c) encouraging students to use manuals and other available materials while performing their jobs, and (d) telling students that they will be able to transfer their skills to other configurations and other types of equipment. A preliminary quantitative evaluation of the HITT strategy found that HITT-trained students performed all tasks (even those they had not been trained to perform) significantly better than students trained with the SAT strategy (even though the HITT students had significantly lower aptitude scores). The authors conclude that the HITT strategy is successful because it "...is firmly based on extensive research on how to enhance transfer of training."

12. Fitzsimons, B. (1993). Training equipment and methods for modern combat aircraft. Military Simulation and Training, 4, 31-35.

The Royal Air Force (RAF) recently introduced a new trainer aircraft, the Tucano. The Tucano requires students of a higher skill level than previous aircraft because it has a tandem rather than side-by-side seating arrangement (which reduces instructor observation of the student's performance). Part task trainers (PTTs), cockpit procedure trainers (CPTs), computer-based training (CBT), and video films were all employed, resulting in well-trained student pilots. Before the use of the CPTs, skills such as cockpit familiarization and emergency cockpit procedures were taught in the full-motion simulators, thus reducing the amount of time the simulators were available for their primary training mission. In general, a lack of training devices for the more basic skills usually is found. The RAF also is attempting to improve training through political means. The



training needs of the future EuroFighter 2000 aircraft are now being addressed. A simulator will be delivered to pilots six months before the actual aircraft to train pilots and to evaluate the training simulator itself before more are built.

Helmet-mounted simulators have also been used extensively in training, mainly as a way to eliminate the cost of complex image projection systems. However, the image quality of even the best helmet-mounted systems is still poor and helmet-mounted systems may cause considerable simulator sickness. A large research project, EUCLID, is currently underway by several large UK defense contractors. Four simulation-related areas are being researched: (a) performance requirements for various simulation subsystems to promote realism, (b) strategies for effective use of networked training systems, (c) the integration of environment and battle simulators, and (d) redesigning the instructor's control panel and functions to reduce workload.

13. Foshee, N. H., & Martin, B. L. (1994). Providing military occupational training using community colleges and video teletraining. Proceedings of the Interservice/Industry Training Systems and Education Conference, 16, paper 3-10.

An evaluation of video teletraining (VTT) via community colleges for Reserve Component (RC) soldiers is presented. For this evaluation, course instructors were community college instructors, not military personnel. Therefore, the interaction between military and community college personnel was also evaluated. Five courses were taught to a total of 275 students in three remote sites (sites other than the origination site). A total of 40 different analysis tools were developed for assessing the VTT. Students performed well on performance tests. In addition, subjects subjectively rated VTT at community colleges as more preferable than VTT at other sites, and they rated VTT over traditional instructional methods at every site. However, students said that VTT prevented personal relationships with the instructor. The authors conclude that VTT has potential because: (a) military training can be converted to the VTT format, (b) students preferred the VTT, (c) all students passed the courses, and (d) community colleges are capable of teaching military subject matter.

14. Gluckman, J. P., & Willis, R. P. (1994). Intelligent embedded trainers: A next step for computer based training. Proceedings of the Interservice/Industry Training Systems and Education Conference, 16, paper 3-10.

The authors describe the integration of simulation (which provides a realistic learning environment) with intelligent



tutoring systems (which provide feedback and instruction) to produce an Intelligent Embedded Trainer (IET) system for the U.S. Navy. The intelligent tutoring component of the training system contains a model of human decision making and problem solving (KOALAS). This model is compared to the student's performance during the training simulation and to the student's answers to questions that explore the student's mental model, reasoning, and progress. "This implementation ...allows training to be tailored to individual needs and for all aspects of the training to be independent of the scenario used." The resulting proof-of-principle system is designed to train complex cognitive skills (in this case, electronic warfare), but no empirical evaluation of the system is reported. Challenges to the production of an IET include the development of a standardized architecture that would allow an IET to be used with many training techniques.

15. Goehring, D. J. (1994). Interactive Hypermedia for Tactical Training (ARI Technical Report 1013). Alexandria, VA: U.S. Army Research institute for the Behavioral and Social Sciences. (AD A286 051)

The author examines the ability of a hypermedia training system to teach military tactics. Hypermedia is defined as "...a technology for organizing discrete quantities of information, termed informational nodes, for utilization in an arbitrary, nonsequential manner by traversing links between information nodes." Hypermedia allows users to proceed at their own pace and according to their own interests. "Learners progress faster, retain more, and enjoy it more when they are meaningfully involved in the process."

The author used data from a previously-executed National Training Center (NTC) exercise as the example hypermedia-based training scenario. This data provided junior officers with example exercises from which they could learn and derive lessons learned. The NTC data consisted of a scenario that was repeated twice by the same unit; the first attempt was not successful, but the second was. The system allowed trainees to view the battles as they progressed, compare successful and non-successful attempts, and receive evaluation and feedback. Some of the problems encountered with the training program were based upon the incompleteness of the NTC data.

16. Gorman, P. F. (1986, December). Educational technology: Yesterday, today, and tomorrow. Military Review, 66(12), 4-11.

This article argues that traditional school systems and paper-based instructional systems can no longer meet the Army's need for well-trained, combat-ready soldiers. In addition, with the impending budget restrictions there are three important choices facing the Army: (a) training for unit readiness or individual readiness, (b) training investments or continued equipment modernization, and (c) establishing standards of performance horizontally or vertically. Gorman argues that educational technology could prevent these choices from being either-or. Improved instructional technology could provide training at the unit's locations that is equivalent to the training provided by specialized schools. Gorman also advocates integrating the various ongoing research efforts to focus on basic questions. "Were I one of the Army's leaders, I would be looking with urgency for a way to pull all that disparate, largely research-oriented effort together to focus on the larger question." That larger question is understanding the best way to train for future air-land battles, which is the most likely future operation.

17. Grady, J. E. (1994, February). SIMITAR: Guardsmen get an edge. Army, 43(3), 44-45.

This article outlines Advanced Research Project Agency's (ARPA's) Simulation in Training for Advanced Readiness (SIMITAR) program, which seeks to improve Army National Guard (ARNG) soldier combat skills. As part of the effort, valid measures of performance and predictors of success are being developed. A major objective of the SIMITAR project is to maximize the effectiveness of the limited training time available to Guardsmen. This goal will be achieved in part by developing transportable, reconfigurable simulators, which will eliminate costly travel to centralized training centers. The commanders of ARNG units will learn how to be commanders rather than serve as trainers for subordinate units. Other potential training methods include portable laptop computers and electronic communication from home.

18. Halff, H. M. (1994). Adventure games for technical education. Proceedings of the Interservice/Industry Training Systems and Education Conference, 16, paper 2-2.

The author describes the development of a computerized game-based instructional system designed to teach technical information and skills. "Computer-based adventure games are computer games in which the player assumes the role of a character in some fictional scenario." Game-based training programs potentially have two advantages over typical training methods: increased opportunity to practice skills, and increased student motivation. It is hoped that while students have fun playing a game, they will "accidentally"

learn. Computerized game-based training systems also have all of the benefits of multimedia software: hypertext, sound effects, full-motion animation, a structured progression (crawl, walk, run), and compatibility with desktop computers. Because of these advantages, the author argues that game-based training systems are well suited to the training of technical and scientific topics. A game-based training system (*Electro Adventure*) was designed and evaluated by the author for the Navy. The game was designed to teach basic electrical concepts. The author includes a list of the personnel required and procedure followed to create the game-based training system, as well as a list of practical lessons learned from this development process. Also included are the results from a preliminary evaluation of the game's teaching ability. The adventure game was compared to traditional classroom lectures and two computer-based instructional (CBI) systems by analyzing student scores on a post-training test. Student performance was roughly the same for all training systems. However, students rated their confidence of their knowledge after game-based training as poor. The author concludes that the adventure game fared well when considering that it is in its first generation. Halff feels that game-based training systems deserve more funding and development to further assess their potential.

19. Howard, M. (1993, Fall). Simulations: A new way to train. Army Reserve Magazine, 39(3), 28.

The rising cost of ammunition, fuel, and equipment maintenance, along with environmental concerns and base closings, have provided ample justification for the use of simulation in training. Early simulation devices and exercises did not train combat support and combat service support, but new simulators that address these needs now exist (e.g., the truck driver trainer) or are in development. These future simulators include: a vessel bridge simulator, a crane simulator, and an engagement skills trainer. Several Battle Projection centers, currently under construction, will provide additional computer-based training.

20. Lane, L. (1994, November). Sights on simulation. Soldiers, 42(11), 18-20.

The author describes current evaluation efforts of the Close Combat Tactical Trainer (CCTT), a new high-fidelity tank simulator that is a component of the Combined Arms Tactical Trainer (CATT). The Army Optimization Team (AOT), a group of active duty and National guard soldiers, has been involved in the design process and provided feedback on various aspects of the simulator. The feedback was noted by

computer engineers and human factors experts, who could then alter the design of the simulators, if necessary. The simulator's capabilities include: (a) environment, weather, and time of day manipulation, (b) inclusion of dismounted soldiers, and (c) higher overall fidelity than SIMNET. The simulators will allow soldiers to learn from trial and error while eliminating the cost and dangers of making errors. The first CCTT is expected to be delivered in late 1996.

21. Leibstone, M. (1993). U.S. training industry preview. Military Simulation & Training, 6, 19-22.

An overview of training and simulation capabilities of the U.S. Army, Air Force, and Navy is provided. The author notes that U.S. military simulation seems to be divided into several areas, including: system and component testing, system user training, concept development, multiple system interaction training, and strategic and tactical training. In particular, the Army has used simulation in all phases of new equipment development, from the initial concept to training after construction and delivery. In addition, simulation is used on a much larger scale now. One specialty of the Army is the use of networked simulators, most notably the SIMNET facility at Fort Knox. Simulation has significantly reduced the cost of training. For example, the use of simulation to replace live fire exercises has reduced training cost by \$40 million, just through the reduced use of live ammunition. The U.S. Air Force has used simulation-based training for many years for all types of aircraft. The Air Force, however, does not use networked simulation as much as the Army. Most current simulation development efforts are constructing specialized trainers such as electronic warfare trainers. The Navy's central flight simulation center is the Manned Flight Simulator (MFS) facility at the Naval Air Warfare Center in Maryland. Much more than simple flight skills are trained at this facility. Additional training is received on weapons use, threats and corresponding pilot procedures, system breakdowns, night and poor weather operations, and in-air refueling. Other simulators at the MFS are capable of advanced flight dynamics modeling for any aircraft, thus enabling flight scenario replication. The future of simulation in the U.S. military is seen as being controlled mainly by funding. Possible future simulation efforts would consolidate simulation's many uses into a single, all-purpose simulation system. Another future development will most likely be the improvement of virtual reality technology.

22. Lhotka, P. H., Gorrell, T. W., Rose, T. L., Butler, J. M., Semrau, S. A., Taylor, C. L., & Smith, T. L. (1994, Summer).

Lessons learned from a CBT development team. Journal of Interactive Instruction Development, 7(1), 23-29.

Lessons learned from the development of Air Force computer-based training (CBT) systems are provided. Students are asked to provide feedback on the training systems in an effort to improve future systems. The suggestions focus upon three major topics: resource acquisition, project development procedures, and courseware implementation. Lessons learned related to resource acquisition include: prevent hardware from driving the design of the courseware, analyze training requirements before selecting authoring software (the software used to create the courseware), ensure support from higher levels of management, specify support requirements, and forecast funding requirements in advance. Lessons learned related to project development procedures include: assemble an experienced development team, attend training conferences, conduct in-house training for the development teams, know the targeted students, establish design standards early, promote teamwork, involve the programmer from the beginning of the program, back-up data often, and review all lessons after they are produced. Lessons learned related to courseware implementation include: labeling the courseware in an understandable and professional manner, solicit user evaluations, and providing customer support. Overall conclusions emphasize the critical importance of planning, early identification of requirements, and upfront analysis for successful courseware development.

23. Lok, J. J. (1994, June 25). Training worlds to collide at Reforger. Jane's Defense Weekly, 21(25), 23.

The author describes efforts to make the October 1994 Reforger (AKA Synthetic Theater of War - Europe (STOW-E)) the first demonstration of a synthetic theater of war in which simulators and real troops are combined in a single training scenario. Live troops in Germany were combined with simulator-based troops in Germany and Ft. Rucker, Alabama. (The Alabama troops were linked via the trans-Atlantic fiber optic cable, which provides smaller delays than satellite-based communication.) This effort is a step toward U.S. Army Simulation Training and Instrumentation Command's (STRICOM's) goal of establishing a fully-interactive family of simulators. A family of compatible simulators, with simulations of all major weapon systems, will allow trouble-free combined arms training. These future simulators, known collectively as the Combined Arms Tactical Trainer (CATT), will also be able to interface with other simulation tools such as WARSIM 2000, a future constructive simulation tool.

24. Löttscher, F. (1994). Command simulation training in the Swiss army. Military Simulation and Training, 5, 6-12.

The Swiss Army recently purchased four simulation-based command simulators. These simulators will help senior Swiss Army officers to become more effective leaders. Simulation was chosen over other training methods because, "conventional training methods simply cannot achieve the degree of true-to-life reality and intensity required for training in combined arms combat and commanding major forces." Three of the simulators train commanders at the battalion/brigade level, the fourth trains at the division/corps level. All simulated battles occur on a digital representation of land in Switzerland. Commanders can battle against computer-generated enemies or other students. Two basic types of exercises are used. In the simple combat simulations, training focuses on battlefield command and staff techniques. In the combined arms combat simulation, training focuses on decision-making, issuing orders, battlefield command, and staff techniques. Training exercises usually are two to three days in duration to allow scenarios to fully develop. The simulation facility has built-in feedback mechanisms which, by providing a comprehensive statistical description of the battle and periodic snapshots of unit movement, allow periodic after-action reviews.

25. Malham, M. C. (1993, March/April). Technology and tank maintenance. Armor, 103(2), 45-46.

This article describes two expert systems developed by Director of Combat Development's (DCD's) Knowledge Engineering Group (KEG) at Fort Knox to teach diagnostic maintenance skills to M1 mechanics. Expert systems are computerized forms of human knowledge and expertise, which can be used by non-experts to solve problems and increase expertise. An expert system is comprised of two main components: the knowledge base, which stores information, and the inference engine, which solves the presented problems by using the knowledge base.

The first maintenance-related expert system is the Diagnostic Intelligent Tutoring System (DITS). The DITS is a prototype training system intended to help mechanics maintain easily forgotten skills. It was originally constructed as a proof-of-principle system to assist troubleshooting for the M1's thermal sights. The system provides user-specific training by adapting the instruction to the individual's skill level, experience, and learning style. DITS also tracks a student's progress through the program and can provide overall ratings of the student's strengths and weaknesses.

The other training program, the Turbine Engine Diagnostics (TED) system, assists malfunction diagnosis, parts ordering, and repair procedures for the M1 engine. Like DITS, TED also adapts to the individual user's level of expertise. The repair procedures are presented as an electronic manual and include explanations of how and why specific procedures are performed.

Additional systems that are technology-based but not expert-system based are being developed. The Interactive Electronic Technical Manual (IETM) is designed to replace paper manuals, thus providing rapid information access, weight reduction, easier distribution, and less storage requirements. No empirical evaluations of these three maintenance assistance systems are provided.

26. Martin, P., Maddux, G. A., & Farrington, P. A. (1994, May/June). Training for concurrent engineering success. Army Research, Development and Acquisition Bulletin, 15-18.

Department of Defense directives now mandate the use of concurrent engineering (CE) in the design of all new weapon systems. According to CE, "...all aspects of the product, from conception through disposal, [should] be considered during the initial design of the system." Therefore, user training must now be considered when designing a new military system. This article details a training program developed by a multi-disciplinary task force to teach the principles of CE to design personnel at Missile Command (MILCOM). The training program consisted of seven modules that were delivered via just-in-time training. In particular, CE was trained just prior to the formation of the managerial structures of a design effort. The training program was judged successful, although no evaluation of the training system is mentioned.

27. Mastaglio, T. W., & Rozman, T. R. (1994, February). Expanding training horizons. Army, 43(3), 39-42.

The authors discuss the advantages of device-based training, which include reduced cost, increased safety, increased control over the training scenario, digital recording of the training event, and more informative after-action reviews (AARs). The authors stress the importance of understanding which skills (procedural and cognitive) are best learned in which environments (simulation or the field). With such an understanding, the proper balance between field exercises and simulation can be determined. Currently projected training strategies for the years 1995-2000, based on the Army's Combined Arms Training Strategy (CATS), greatly rely on distributed interactive simulation. However, many of the current strategies to integrate simulation with field



exercises are viewed as inadequate, mainly because the development of specific training plans is often delegated to lower-ranking officers who receive little guidance. Therefore, the development of a training program to develop commanders into training experts is advocated. The authors argue that simulation should be used as a "gate" through which soldiers must pass before being allowed to participate in large-scale field training exercises. The authors conclude by stressing that basic research, performed by organizations such as the Army Research Institute (ARI) and the Army Research Office (ARO), is advocated as a means to develop more effective training integration strategies.

28. McCarthy, J. E., Pacheco, S., Banta, H. G., Wayne, J. L., & Coleman, D. S. (1994). The radar system controller intelligent training aid. Proceedings of the Interservice/Industry Training Systems and Education Conference, 16, paper 5-2.

When compared to the limitations of books and classroom instruction, the authors argue that assigning students to individual tutors is vastly more effective, although very expensive. With the aid of computer-based Intelligent Training Aids (ITAs), however, a computer-based version of this ideal tutor can be achieved at a significantly lower cost. Computer-based ITAs can provide simulations of real-world tasks and concurrently assess a student's performance, adjusting instructional style and feedback accordingly. The ITAs typically consist of four components: (a) a learning environment, which defines the set of tasks the student must master, and a student-device interface, which defines the modes of communication that are possible between the training device and the student; (b) a domain expert, which contains extensive knowledge relevant to the learning environment; (c) a student model, which contains the computer's representation of the student's performance, expertise level, errors, and problem solving strategy; and (d) an instructional expert, which represents the knowledge of a training expert. Of these four components, the instructional expert module is the least developed because basic research on instructional design is poorly advanced. The instructional expert module must perform three important functions: decide when to interrupt practice for additional instruction, when to provide positive feedback, and what instructional format is best suited for the student.

The Radar System Controller Intelligent Training Aid (RSC ITA) is provided as an example of such a system. The system assumes an expert/novice relationship between the training system and the student. During a simulated training task, the ITA observes the student's responses, assesses the student's progress and comprehension, and provides feedback



when necessary. In the case of the RSC ITA, the four basic components of ITAs (listed above) were defined as follows: the learning environment was the RSC workstation, the domain expert contained a list of expected actions that the student should perform after specific events in the simulation, the student model assessed the student's declarative, procedural, and contextual knowledge, and the instructional expert was kept as simple as possible. The authors conclude, "...the master/apprentice paradigm is appropriate whenever the training task could best [sic] be accomplished through direct work-related tutoring." However, no empirical evaluation of the ITA systems is mentioned.

29. Miller, D. (1993). Staff and command simulators: The network solution. Military Simulation and Training, 5, 4-9.

Due to increased training costs, environmental concerns, and the uncertainties of future conflicts, computer-based battle simulation provides an ideal training environment. Initial computer-based simulations were stand-alone systems, but the current trend is toward linking large numbers of simulators to practice large-scale, combined arms maneuvers. The first networked simulation system was Simulator Network (SIMNET), which links tanks, fighting vehicles, helicopters, and jet aircraft. The current standard for simulation is the Distributed Interactive Simulation (DIS) standard. In the DIS standard there is no centralized computer controlling the entire simulation. Instead, each simulator processes its own information and sends small "data packets" over the network to all other simulators. DIS allows a wide number and type of vehicles in a simulation. This flexibility gives the DIS standard potential to be the simulation standard of the future. Future NATO training will be heavily simulation-dependent and will use a standard similar to or based on the DIS standard. Another potential training application of simulation is demonstrated by the Battle of 73 Easting. This battle, which took place during Operation Desert Storm, has been recreated in SIMNET and can be replayed for analysis and training. The potential training benefits of simulation are seen as boundless. "The ultimate scope is a virtual battlefield of immense proportions, which could include as many as 100,000 entities, with actions being on an intercontinental, even global scale."

30. Nash, T. (1993, November/December). Oft forgotten, always vital: Maintenance training. Military Simulation & Training, 6, 6-8.

Due to the increased sophistication of all modern weapon systems, properly trained maintenance personnel are more important than ever before. This importance is well illustrated when considering that a typical maintenance time

to operation time ratio for a modern fighter jet is 15:1. Maintenance training is usually provided by two types of systems, vehicle simulators and computer-based training (CBT). The use of vehicle simulators allows mechanics to practice actual repairs on full-sized replicas of fielded equipment. Such a simulator allows students to learn independently of the availability of an actual vehicle while increasing safety and reducing the risk of damaging actual equipment. These vehicle simulators have been produced for the F-15E Strike Eagle and the M2A1/3A1 Bradley Fighting Vehicle. Students can train in one of several modes: specific fault detection and correction, procedural maintenance, or freeplay. In any mode, the training system records all student actions for later analysis. Other vehicle simulators focus on providing generic training, such as the Generic Airborne Radar Maintenance Trainer (GARS) and the Aircraft Power Supply Trainer (APST). These generic trainers are primarily used for initial training, before mechanics specialize.

CBT has been recently applied to maintenance training due to increased usability and reduced costs, but it is still not very common. CBT is used in the classroom and individually. One trend is to store maintenance manuals on a computer, which enables faster access to information during repairs. This application of computers is blurring the distinction between training and task performance support. The final judgment of CBT's applicability to maintenance training has not yet been determined, but support is increasing. No empirical evaluations of these training systems are mentioned.

31. Norton, J. E., Gonzalez, G. C., Gomez, C. C., Kline, K. B., & Regian, J. W. (1995). The use of gaming for intelligent technical training (AL/HR-TP-1994-0028). Brooks Air Force Base, TX:- Armstrong Laboratory/Human Resources Directorate.

In an effort to improve student motivation, a game-based computer training program was developed and compared to a similar, non-game training program. The authors argue that a game format can increase motivation through several factors: immediate feedback, clear goals, fast-paced action, variable difficulty levels, easily viewable improvement, and randomness. A previous study that evaluated a game-based training program (*Electro Adventure*, see Halff, 1994) found no significant advantages for game-based designs. The current authors suggest that this previous program may have been designed with an inappropriately large emphasis on graphics and fun rather than training. The authors reason that if a game-based training program could be more tightly integrated with the

task to be learned, the advantages of game-based designs would become apparent.

In an effort to prove this point, a game-based computer training program, the Automotive Component Troubleshooting in a Visual Environment (ACTIVE), was designed to teach troubleshooting skills for an automobile engine. The student was cast as both the mechanic and driver of a race car. The student must troubleshoot the vehicle to complete as many laps as possible. Results found similar post-test scores for all groups, although subjects in the game-based condition actually had less instructional time. Subjects in the game-based condition also had increased subjective ratings of motivation and enjoyment. This initial development phase is considered a success and further game-based training development is underway.

32. Perez, R. S., & Seidel, R. J. (1986). Cognitive theory of technical training. Advances in Reading/Language Research, 4, 139-163.

Several areas of cognitive research can be applied to training: (a) the representation of knowledge in the brain, (b) individual differences, (c) metacognition, and (d) cognitive components that correspond to the performance of cognitive tasks. The potential benefit of applying cognitive theory to training and instruction is a thorough understanding of how knowledge is represented, organized, accessed, and processed. Once this is understood, technical training can be better organized and designed, resulting in more organized knowledge representations within the learner's brain. "...The goal of technical training is the development of soldiers who think and behave like experts." The authors conclude that much more research is needed before all questions about human cognition have been answered.

33. Pisel, K. P. (1994). An analysis of distance learning applications for joint training. Proceedings of the Interservice/Industry Training Systems and Education Conference, 16, paper 2-6.

The author provides a systematic comparative analysis of 14 possible training media, including printed text, audiotape, videotape, computer-based instruction (CBI), simulation, multimedia, telecourses, and computer-based conferencing. Aspects of the systems that were considered in the analysis include media capabilities, interoperability, and cost-benefit factors. A rating system was developed that measures several factors such as: student-instructor interaction, student-student interaction, instructional feedback, self-pacing, instructor control, adaptability to

learner, ability to fit various time schedules, realism of simulated scenarios, full-motion video, high-fidelity sound, support of remedial teaching, ability to be referenced after training, support for wide geographic dispersion, and cost. Each of these factors was assigned an importance weight based on the particular needs of the author's training program.

The final results of the evaluation, in order from best to worse, are: (a) telecourse (one-way video, two-way audio), (b) multimedia, (c) intelligent CBI, (d) telecourse (two-way audio and video), (e) simulation gaming, (f) tutorial CBI, (g) computer-mediated conference, (h) audio-graphic, (i) audio conference, (j) videotape, (k) hyper-text, (l) print, (m) audiotape, and (n) non-resident seminar. In addition, a cost-per-student analysis was performed. Telecourses were found to be the most affordable media per student (\$0.83 per student), and CBI was found to be the second most affordable (\$1.00 per student). To maintain the low cost of telecourses, the authors suggest operation within a host facility or renting equipment--any purchased equipment will be very expensive and will become obsolete in a short time. This analysis was designed especially for the author's specific training needs (the administration of a joint forces three-day training course) and student population size. For analyses with different objectives and needs, the importance weight of each evaluation factor should be reassessed.

34. Platt, W. A., & Guynn, S. J. (1994). A strategy model for computer based training. Proceedings of the Interservice/Industry Training System and Education Conference, 16, paper 2-10.

With the introduction of computers into modern society, large promises have been made about the computer's potential benefits. This paper examines the reasons that computer-based training has not yet achieved its theoretical potential. The three major reasons are: (a) computers have their own jargon, (b) computer-based training systems are designed by programmers, who are not necessarily instructional experts, and (c) overall strategies for effective training have not been widely shared among companies and organizations. A survey of the available literature led to the following discoveries: (a) computer technology is still in its infancy, (b) most instructional design guidelines are not supported by empirical evidence, only "pseudo science" (this does not mean that they do or do not work), (c) many course instructors are poorly trained on the operation of the course software and hardware, (d) many courseware designers have their own "style" which represents their own philosophy of instruction, and (e) research should

emphasize the verification of whole training strategies, not individual variables. For the success of a training program, the authors believe that it is very important to determine what must be learned by the student, and then adjust training strategies until this goal is obtained.

In an effort to solve some of these problems and establish a standard method of specifying specific instructional strategies, the authors attempt to develop a three part taxonomy of computer-based instruction strategies. Also, operational definitions of "interactive," "adaptive," "remediation," and "simulations" are provided. The authors argue that the development of a standardized specification system will improve communication between instructional designers and training system purchasers.

35. Preston, A. (1993). CBT -- Military applications. Military Simulation and Training, 4, 21-23.

In military environments, computer-based training (CBT) has replaced simple audio/visual presentation as a primary form of training. The benefits of CBT include: (a) the flexibility to teach a wide variety of topics, (b) data security, (c) pacing to the student's preferred speed of learning, and (d) the ability to track a student's progress and adjust the course of instruction accordingly. Computer-based training, however, is still in its infancy and not without problems. The most prominent problems with CBT are: (a) long development time, (b) high development cost, and (c) large processing requirements for full-motion video and audio. The long development time and high cost may soon be reduced through the use of authoring software, which automates some of the courseware development procedure. Computer-based training is a maturing technology and can now be taken seriously, but it still has much potential to be realized. The effectiveness of CBT is also developer dependent. "Good CBT requires a very high standard of expertise, not only in the didactic method, knowledge of the subject, psychology and technology but in creative terms, with images and with language." There is a general agreement that CBT will not totally replace teachers. Instead, CBT will serve to assist and supplement classroom instructors. Future CBT systems: (a) will likely store student-specific information which can further customize the student's training, (b) will be easier to develop, and (c) will be available on laptop computers for remote or on-the-job training.

36. Quick, D. M. (1994). Determining training resources and requirements for new weapon systems. Proceedings of the Interservice/Industry, 16, paper 3-11.

Determining the training requirements of a new weapon system during its developmental stages is a difficult task. To make matters worse, the training needs analysis typically can be performed only once due to monetary restrictions. Therefore, proper timing of the training assessment within the development process is very important. If done too early, the weapon system's design may change significantly between the training analysis and actual development. If done too late, the opportunity to influence the design of the system diminishes and the time to develop and implement the training plan decreases. This paper describes the Air Force's attempts to integrate the training analysis into the design process itself. The main objective of the Manpower, Personnel, and Training Decision Support System (MPT DSS) is "...to lay the foundation of the training required to maintain and support a new weapon system once it enters the operational inventory. To lay this foundation, the tool allows the user to select tasks for training, assign the tasks to instructional settings, determine task training times, and determine training resource requirements." The MPT DSS is a computer-based analysis tool that allows the visualization of the overall effect of small changes in the proposed training course. The authors conclude that this system enables training assessment earlier in the development process than ever before, which assures better training development and allows influence on the design process itself.

37. Quinkert, K. A., & Black, B. A. (1994, November/December). Training for force XXI technologies. Army Research, Development, and Acquisition Bulletin, 44-46.

These authors believe that the importance of quality soldier training will be amplified with the impending incorporation of advanced digital technology in future weapons systems. To increase its effectiveness in the 21st century, the Army has developed a program called Force XXI. "Force XXI synthesizes the science of modern computer technology, the art of integrating doctrine and organization, and the optimization of quality people with the goal of creating new combat formations operating at even greater performance levels in speed, space, and time." Training is seen as very important for future soldiers because of the potential of complex technology to overwhelm the user.

Several scientific studies performed by the U.S. Army Research Institute (ARI) further evaluated the potential benefits and problems of advanced digital technologies. The studies evaluated Position Navigation (POSNAV), Intervehicular Information System (IVIS), Commander's Independent Thermal Viewer (CITV), and Combat Vehicle Command and Control (CVCC)--all prototypes of the complex,



software-based systems that will be used on the future battlefield. "Major lessons learned [from these studies] indicated a need for not only fundamental warfighting skills, but also training that is more comprehensive, and more systems-oriented." The authors also found that digital skills are dependent upon more than simple procedural knowledge--it requires in-depth training of fundamental skills. Specific lessons learned for training are: (a) teach the underlying fundamentals of the digital systems, (b) establish new Tactics, Techniques, and Procedures (TTPs) and Standing Operating Procedures (SOPs) along with the new systems, (c) teach position-specific skills before digital equipment skills, (d) situational awareness is improved with embedded training tools, (e) embedded training tools can also improve information management, (f) use operational vignettes that focus on specific training objectives and that do not require large numbers of other soldiers, and (g) determine the proper training mix. The authors conclude that "...training must ensure that soldiers have the requisite knowledge and experience from basic concepts through practical applications to fully advantage new weapon systems and information technologies. New training approaches that maximize distance learning, networked simulation, virtual reality, and seamless simulation will require major changes to the methods and strategies used to train soldiers of the 21st century."

38. Raes, D. W. (1994). A methodology for selection of training to apply computer-based instruction. Proceedings of the Interservice/Industry Training Systems and Education Conference, 16, paper 3-1.

This article outlines the Simulation in Training for Advanced Readiness (SIMITAR) program, which attempts to improve the readiness of National Guard troops. "This paper outlines a methodology for identifying critical tasks that are of the highest priority for training and applies an objective method for selecting from those critical tasks ones to apply computer-based instruction (CBI) in order to maximize training effectiveness." The first step of the process is to specify the organization's primary mission, which in turn prioritizes the tasks essential to the attainment of this goal. Of these high-priority tasks, those that cannot be trained "hands-on" with the actual equipment are candidates for CBI. Decision matrices are then used to quantitatively determine task priorities for CBI. "The application of computer-based instruction -- applying an objective measurement to determine the highest payoff tasks--has been an effective and efficient use of developmental resources."

39. Ricci, K. E. (1994, Summer). The use of computer-based videogames in knowledge acquisition and retention. Journal of Interactive Instruction Development, 7(1), 17-22.

This paper details an empirical study that evaluated the usefulness of computerized game-based training as compared to more traditional paper-based training methods. The Navy previously has produced several game-based training packages, but they were non-computerized board games. Two types of computer games can be identified: simulation games and videogames. "Simulation games model a process or mechanism relating input changes to outcomes in a simplified reality that may not have a definite end point. Videogames...are competitive interactions bound by rules to achieve specified goals that are dependent on skill and often involve chance and imaginary settings."

For the empirical evaluation, 60 subjects were randomly assigned to one of three groups: paper-based test, paper-based question and answer, or videogame. Subjects in all three groups studied information about nuclear, biological, and chemical warfare for 45 minutes. The experiment consisted of four distinct phases: a pretest, training, a post-test, and (four weeks later) a retention test. Subjects also provided subjective ratings of the training session. Subjects in the game-based training group rated their training significantly higher than subjects in other groups. An analysis of the post-test and retention scores indicated that the game-based group had superior acquisition and retention. This finding is explained by increased subject motivation and interest. In conclusion, computer-based games are viewed as an effective, low-cost instructional technique.

40. Roberts, D. S. (1993, Fall). The next generation of training. NCO Journal, 3(4), 16-17.

The military is now beginning to incorporate a variety of new technologies into its training courses. These technologies include computer-based instruction (CBI), satellite-linked classrooms, bulletin board systems (BBSs), and interactive study guides (ISGs). Many of these training systems are being used to prime students before formal classroom instruction. This priming assures a common foundation among all students, thus maximizing productive classroom time. Benefits of this new technology include: reduced cost due to elimination of training travel, increased instructor focus on more important issues such as the proper application of knowledge, and a transition to individualized instruction. Advanced user interfaces mean that soldiers do not have to be computer literate to use the new training technology.



41. Robinson, J. D. (1994, June 30). Comanche: A new weapon system for a new age. Army Aviation, 42(6), 6-10.

The foreseen role of the new Comanche armed reconnaissance helicopter (RAH-66) is the "quarterback" of the digital battlefield. Through the Integrated Mission Support System (IMSS), Comanche will relay masses of digital reconnaissance information to all other friendly units, thus allowing commanders to see the entire battlefield. Like most other new-generation and future weapons systems, the Comanche is very complex and highly computerized. The greatest challenge associated with this vehicle, however, is not its design or construction, but the selection and training of pilots who can allow realization of the Comanche's potential. Simulation will play a major role in pilot training and the development of new tactics, techniques, and procedures (TTPs) associated with the Comanche. The Aviation Combined Arms Tactical Trainer (AVCATT), a future simulator, will play a major role in this task. The author concludes by reminding the reader that "...soldiers, not machines, are the key to decisive victory."

42. Smith, R. L. (1994, May/June). Apache maintenance trainer for the future: AET-A7. U.S. Army Aviation Digest, 42-44.

The armament and electrical trainer (AET-A7) is a newly developed Apache helicopter maintenance trainer. At the heart of the AET-A7 is a crash-damaged Apache helicopter that has been remanufactured into a full-sized, hands-on, computer-controlled maintenance trainer. The system includes an instructor's console from which artificial faults can be created and student performance monitored. The AET-A7 offers a high fidelity, full-sized simulation of the entire Apache helicopter. This training system eliminates the need to train maintenance personnel on actual vehicles, thus reducing the risk of damage to operational systems and eliminating equipment availability problems.

43. Swords, M. J., & O'Byrne, J. (1994). Information age command and control training. Proceedings of the Interservice/Industry Training Systems and Education Conference, 16, paper 1-6.

Advanced technology soon will be available to all fighting forces--the only factor that will distinguish the winners from the losers will be training. The Marines are attempting to improve training with a new program designed to teach command and control. The course has two major phases: first basic skills are taught via student-mentor methods, then students move to a problem solving mode. Basic skills include learning about operating systems (e.g., UNIX), local area networks (LANs), data bases, computer-

based maps, and electronic libraries. Students then progress to a problem solving mode in which they learn command and control by playing war games and using the Combined Arms Staff Trainer (CAST). Training concludes with a final test, the Combined Arms Exercise (CAX).

44. Walters, B. (1994). Training systems for AFVs. Military Simulation and Training, 3, 6-10.

Due to environmental and monetary concerns, a growing percentage of training time for Armored Fighting Vehicle (AFV) crews is spent in simulation. Some simulation-based training systems are part-task trainers for one specific crew member. The current trend, however, is toward whole-vehicle simulators linked through Distributed Interactive Simulation (DIS) technology. With these training systems, vehicle crews can practice large-group exercises and conduct mission rehearsals, not just task repetition. Joint missions between air, land, and sea forces can also be rehearsed. The paper goes on to describe the features of various international AFV simulation-based trainers, such as France's Leclerc Tank Crew Simulator and other South American and Israeli systems. Other training systems briefly discussed include desktop part-task trainers and laser-based gunnery trainers for use on the firing range.

Table 1

## Recommended Training Techniques from Military Articles

| Military Reviews              | Training Techniques |                         |                   |                     |                        |                       |                    |            |            |                      |                 |
|-------------------------------|---------------------|-------------------------|-------------------|---------------------|------------------------|-----------------------|--------------------|------------|------------|----------------------|-----------------|
|                               | Basic Skills        | Computer-Based Training | Distance Learning | Game-Based Training | High Transfer Training | Joint Forces Training | Local Area Network | Multimedia | Simulation | Traditional Training | Virtual Reality |
| Alexander, 1994               |                     |                         |                   |                     |                        |                       |                    |            |            |                      | +               |
| Bishop, 1992                  |                     | +                       |                   |                     |                        |                       | +                  |            |            |                      |                 |
| C' de Baca, 1993              | +                   |                         |                   |                     | +                      |                       |                    |            |            |                      |                 |
| Chenvert, 1994                |                     | +                       |                   |                     |                        |                       |                    |            |            |                      |                 |
| Dorr, 1994                    |                     |                         |                   |                     |                        | +                     |                    |            |            |                      |                 |
| ECC International Corp., 1995 |                     | +                       |                   |                     |                        |                       |                    |            |            | -                    |                 |
| Edwards, 1994                 | +                   |                         |                   |                     |                        |                       |                    |            |            |                      |                 |
| Ellertson & Kloecker, 1994    |                     |                         |                   |                     |                        | +                     |                    |            | +          |                      |                 |
| Finley & Sanders, 1994        |                     |                         |                   |                     | +                      |                       |                    |            |            |                      |                 |
| Fitzsimons, 1993              |                     | +                       |                   |                     |                        |                       |                    |            | +          |                      |                 |
| Foshee & Martin, 1994         |                     |                         | +                 |                     |                        |                       |                    |            |            |                      |                 |
| Gluckman & Willis, 1994       |                     | +                       |                   |                     |                        |                       |                    |            | +          |                      |                 |
| Gorman, 1986                  |                     |                         |                   |                     |                        |                       |                    |            |            | -                    |                 |
| Grady, 1994                   |                     | +                       |                   |                     |                        |                       |                    |            | +          |                      |                 |
| Half, 1994                    |                     | +                       |                   | +                   |                        |                       |                    | +          |            | -                    |                 |
| Howard, 1993                  |                     |                         |                   |                     |                        |                       |                    |            | +          |                      |                 |
| Lane, 1994                    |                     |                         |                   |                     |                        |                       |                    |            | +          |                      |                 |
| Leibstone, 1993               |                     |                         |                   |                     |                        |                       |                    |            | +          |                      | +               |
| Lhotka et al., 1994           |                     | +                       |                   |                     |                        |                       |                    |            |            |                      |                 |
| Lok, 1994                     |                     |                         |                   |                     |                        |                       |                    |            | +          |                      |                 |
| Lötscher, 1994                |                     | +                       |                   |                     |                        |                       |                    |            | +          |                      |                 |
| Mastaglio & Rozman, 1994      |                     |                         |                   |                     |                        |                       |                    |            | +          |                      |                 |
| McCarthy, et al., 1994        |                     | +                       |                   |                     |                        |                       |                    |            | +          | -                    |                 |
| Miller, 1993                  |                     |                         |                   |                     |                        |                       |                    |            | +          |                      |                 |
| Nash, 1993                    |                     | +                       |                   |                     |                        |                       |                    |            | +          |                      |                 |
| Norton, et al., 1995          |                     |                         |                   | +                   |                        |                       |                    |            |            |                      |                 |
| Pisel, 1994                   |                     | +                       | +                 |                     |                        | +                     |                    | +          | +          |                      |                 |
| Platt & Gynn, 1994            |                     | +                       |                   |                     |                        |                       |                    |            |            |                      |                 |
| Preston, 1993                 |                     | +                       |                   |                     |                        |                       |                    |            |            |                      |                 |

(table continues)

Table 1 (continued)

|                           |   |   |   |   |  |   |  |  |   |  |   |
|---------------------------|---|---|---|---|--|---|--|--|---|--|---|
| Quinkert & Black,<br>1994 | + |   | + |   |  |   |  |  |   |  | + |
| Raes, 1994                |   | + |   |   |  |   |  |  | + |  |   |
| Ricci, 1994               |   |   |   | + |  |   |  |  | + |  |   |
| Roberts, 1993             |   | + | + |   |  |   |  |  |   |  |   |
| Swords & O'Byrne,<br>1994 | + | + |   | + |  |   |  |  | + |  |   |
| Walters, 1994             |   |   |   |   |  | + |  |  | + |  |   |

Note: (+) = positive factor  
 (-) = negative factor  
 ( ) = no opinion given/not discussed

## Appendix B

### Annotated Bibliography of Education Articles

1. Armstrong, C. J. (1991). New approaches in the training and education of online users. Online Review, 15(3/4), 147-171.

The use of computer-based, online research is increasing. What was once the domain of librarians is now a skill that many people must learn. Actual online connections are very expensive, however, so users cannot learn to use the system through on-line experimentation. Various training aids are now being developed to assist inexperienced users, but the training medium with the most potential is computer-assisted instruction (CAI). Computer-assisted instruction can be used as many times as necessary without additional cost after the initial purchase, it is used in the workplace at any time, and it does not require expensive links to remote computers. To be effective, these packages are typically organized into progressively more advanced lessons. An example CAI program is described. Computer-assisted instruction is judged to be very effective because it is presented on the same device that will be used to perform the actual task (a computer). It also allows hands-on training via simulations of actual information search tasks.

2. Auld, L. W. S., & Pantelidis, V. S. (1994, January/February). Exploring virtual reality for classroom use: The virtual reality and education lab at East Carolina University. Tech Trends, 39(1), 29-31.

The authors describe current efforts in the virtual reality (VR) and education laboratory at East Carolina University to determine VR's potential in education. Virtual reality has been traditionally developed for military or business use, with little effort focused toward educational applications. Virtual reality is expected to exploit the fact that many people learn well when visualization is used during teaching. Eight primary educational applications of VR are identified: exploring existing places (a virtual field trip), exploring existing things (the human body, a volcano, the ocean floor, the lunar surface, etc.), creating places and things that do not exist, interacting with real people in remote locations, interacting with real people in imaginary places (such as a prototype building design, to judge the design's suitability), interacting with people in unrealistic ways, creating and manipulating abstract representations (can be used to visualize complex data structures or mathematical functions), and interacting with virtual (artificial) beings. Virtual reality is seen as having incredible potential for expanding student knowledge, awareness, experience, and creativity. However, the biggest

disadvantage of VR is that more advanced systems currently are very expensive. The virtual reality and education lab at East Carolina hopes to become a clearing house for VR-related information.

3. Ball, J., & Cook, B. (1994). Texas facility serves as a hub for distance learning. Technological Horizons in Education Journal, 22(5), 64-68.

This article describes the capabilities and services of the R. Jan LeCroy Center for Educational Telecommunications in Dallas, Texas, which include taped and live local telecourses, satellite-based nation- and world-wide telecourses, teleconferences, and television programs for K-12. The LeCroy Center has served local public schools, local and national colleges and universities, the Texas state government, and businesses. The authors argue that distance learning can provide fast, high-quality access to knowledge for geographically dispersed persons at a low cost.

4. Collins, D., & Bostock, S. J. (1994). Educational effectiveness and the computer conferencing interface. Educational and Training Technology International, 30, 334-342.

The goal of distance learning is to provide part-time, remote students with the same high quality instruction that full-time, local students enjoy. This article describes a distance learning system based on asynchronous computer conferencing. Students participate in the conference through personal computers connected to a central computer by modem. Since the conferences are asynchronous, students and instructors do not need to connect to the conference at any specific time, allowing students to connect and learn at their convenience. Conferences are a series of "posts" or messages, grouped by topic, that students can access, read, and respond. Five major problems with mainframe/dumb terminal computer conferencing are: low computer literacy of some students, technical problems with communications, the conferencing software interface, integration with other software, and a limited access to previous messages within a conference. The authors developed a Windows-based software program for personal computers, the Friendly Interface for Conferencing System (FICS), which was designed to overcome many of these problems. The FICS is a prototype and is currently being tested. In addition, various types of conferences were created for different purposes that varied in size, content, level of formality, and memberships (e.g., some conferences were student only). Additional benefits of the conferencing include the relative anonymity of participants, more thoughtful questions and answers (because

all communication is text-based rather than spontaneous speech), and a permanent record of all communication.

5. Cook, E. K., & Kazlauskas, E. J. (1993). The cognitive and behavioral basis of an instructional design: Using CBT to teach technical information and learning strategies. Journal of Educational Technology Systems, 21(4), 287-302.

This article summarizes efforts to establish computer-based training (CBT) production guidelines, based upon principles of cognitive psychology and learning theory, to improve CBT effectiveness. The CBT program was designed for students learning English and basic information about Western culture. Cognitive and learning theory were used because previous studies had shown that these students could not generalize from learned information and could not relate new information to known information. Three basic types of knowledge were tested for each lesson: knowledge and basic recall of the material, comprehension and understanding of the material, and application of the information in a new situation. Each lesson was composed of six segments: gaining the attention of the student, informing the student of the lesson objective, stimulating the recall of prior learning, presenting the stimulus material, providing learning guidance, and eliciting performance. After each lesson, the students were given an on-line performance report. Simulations are an excellent example of cognitive instruction because they allow students to form mental models of the task(s) they must later perform. Learner control of training was provided at four levels: choice of content, navigation strategies, study skill strategies, and self-monitoring strategies. Lesson templates were created to establish specific design guidelines for software developers. The authors conclude: "The best way to teach technical information and learning strategies using CBT is to establish an accurate and solidly researched foundation of learning theory and apply guidelines based on the characteristics of the trainee population. After this is accomplished, one may create lesson templates and text and graphics specifications that will ensure consistency and at the same time be theoretically sound." No empirical evaluation of the proposed guidelines was performed.

6. Farrington, G. C., & Eleey, M. (1994). Penn's plans for integrating emerging technologies. Technological Horizons in Education Journal, 22(3), 104-106.

An ad hoc group of University of Pennsylvania faculty, staff, and students have formed the Committee on Electronic Publishing and Interactive Technologies. This group discusses the potential impact of emerging communication and information technology on the role of the university.



Several specific issues are addressed. First of all, the authors discuss the utilization of new network technologies such as telecommunications and Local Area Networks (LANs) to create a "virtual university." A truly networked university allows: online access to library collections, using electronic mail (e-mail) to expand advising beyond office hours, improved course registration, extended class discussions, and study group collaboration. In addition, new forms of academic publishing, known as "discbooks," can store information that is not limited to serial access, unlike traditional textbooks. The third issue is that new faculty members may need training before becoming an author of a discbook. Another issue is that these new technologies have serious consequences for the university library. It will become less of a physical storage facility and more a distribution center of electronic information as more and more published material is stored digitally. Finally, coherent integration of current practices with new technology is important. In conclusion, the committee believes we should always remember that "...technology's role is to enrich the ways in which faculty and students interact and to make learning a more, not less, human and personal process."

7. Hapeshi, K., & Jones, D. (1992). Interactive multimedia for instruction: A cognitive analysis of the role of audition and vision. International Journal of Human-Computer Interaction, 4(1), 79-99.

"The general aim of this article is to review experimental work relevant to mixed-mode information presentation and to derive from this guidelines for the development of effective multimedia systems for training and education." When developing training programs for use with a specific media, the training must be tailored to that specific modality. Therefore, the development of computer-based multimedia training systems cannot simply use the same guidelines that were developed for film and television. Unfortunately, the advice of training developers was not always heeded during the production of training films, so it may not be heeded during the development of computer-based training programs either. The authors provide a good overview of interactive multimedia instructional systems: "...the essential feature of multimedia is the compelling power of pictures and television combined with the functionality of computers, which place the control at the hands of the user." The authors argue, therefore, that computer-based multimedia may be the ideal training system. "The specific goal for a multimedia training system is to present instructional material in a way that is conducive to learning and long-term retention." This idea is compatible with the "cone of experience" (Dale, 1954), which says direct, purposeful

experiences are the most effective form of learning and text is the least effective. Included in the article is an in-depth analysis of the use of auditory and visual information channels. The article concludes with a list of guidelines for the development of multimedia-based instructional systems.

8. Haugen, H, (1991). Teacher training with new information technology, research and development projects. Education and Computing, 7, 279-287.

This article describes efforts in Norway to understand the role of the computer in the classroom. University research is focusing on what the computer can offer to the teacher and how teachers can be trained to use the computers. The computer is seen as a tool for assisting multiple educational purposes, not as an object to be studied in its own right (e.g., teaching computer programming). Ongoing efforts at various Norwegian schools are briefly discussed. Results of specific research efforts are not discussed.

9. Hirschbuhl, J. J., & Faseyitan, S. O. (1994). Faculty uses of computers: Fears, facts and perceptions. Technological Horizons in Education Journal, 21(9), 64-65.

The authors examine the use of computers in the classrooms at universities in Ohio. The question asked was "What kind of instructors use computers for instruction?" This question is viewed as important because, although higher education collectively has spent billions of dollars on computer equipment in the last decade, computers are used infrequently for instructional purposes. A questionnaire examined various factors such as the instructor's personal attributes, organizational factors, and attitudinal factors. "The only personal attribute that was a consistent predictor of computer adoption was the technological orientation of the faculty's discipline." This finding was interpreted by the authors as evidence that training must be given to faculty members to increase technological knowledge and overcome fears of technology. "The bottom line is faculty should be trained in the use of computers and demonstrate a willingness to adopt computers for instructional purposes before the university launches a technology project" (emphasis in original).

10. Jones, A., & Kember, D. (1994). Approaches to learning and student acceptance of self-study packages. Educational and Training Technology International, 31, 93-97.

This paper describes an empirical study that examined the difference between student learning styles when using a self-learning package. Two styles of learning (surface and

deep) were identified with the Study Process Questionnaire (SPQ), which examines the student's motives and learning strategies. Surface learners are defined as those who skim while reading and attempt to memorize key features. Deep learners are those that concentrate on the underlying meaning. Deep learners are characterized as more independent learners. Two self-learning packages, developed for this study, were distributed to 78 students. Students studied the packages for three weeks and then were tested on the material. Correlations indicated that preference for self-learning was influenced by learning style, with deep learners but not surface learners preferring the self-learning packages. Surface learners completed less of the learning packages than deep learners, and deep learners had a more positive attitude toward the self-learning packages. There was some indication that self-learning packages might cause students to abandon the surface learning strategy.

11. Klemm, W. R., & Snell, J. R. (1994). Teaching via networked PCs: What's the best medium? Technological Horizons in Education Journal, 22(3), 95-98.

This article analyzes three available methods of interactively teaching students on networked computers. The first two methods, electronic mail (e-mail) and Bulletin Board Services (BBSs) are judged as inadequate for several reasons: poor or no graphics capability, messages are posted serially, little or no control of access to specific information, awkward joint editing of documents, and difficulty of archiving for future use. The authors argue that groupware, or desktop conferencing software, is more suited to the task of interactive, network-based teaching. A preliminary test using FORUM (windows-based groupware) in both undergraduate and graduate classes indicated that desktop conferencing holds much promise. A list of available desktop conferencing products and vendors is included.

12. McLellan, H. (1993). Virtual reality goes to school. Computers in the Schools, 9(4), 5-12.

Potential applications of virtual reality (VR) to learning, teaching, and rehabilitation are explored. Many examples of VR applied to learning are discussed, including the Army's Simulation Network (SIMNET) (used for tank training), experiential learning environments (used to teach physics and chemistry), virtual actors (used for rehabilitation), training for team-building and social skills, and virtual field trips (used to visit other times and places). Currently, VR technology is in its infancy--its full potential has only been reached in science fiction novels.

13. Mills, S. C. (1994, January/February). Integrated learning systems: New technology for classrooms of the future. Tech Trends, 27-31.

"Classrooms of the next century will experience great changes due to emerging technologies and new instructional delivery systems." Integrated learning systems (ILSs) are believed to be one of these technologies, because they can benefit learning in a variety of settings and applications. An ILS consists of computer hardware that delivers a specific sequence of software-based instruction (courseware). A typical ILS session begins with a pre-instructional test to evaluate the student's level of knowledge. Based upon these assessments, the ILS system then begins instruction at the student's level. After each lesson, a post-test evaluation is performed, the student's knowledge level is evaluated, and the cycle repeats. ILSs can teach a wide variety of skills in a variety of styles, thus making the systems very flexible. Current trends in ILSs are focused toward increased multimedia content and connecting multiple ILS systems to form networks.

14. Rutherford, L. H., & Grana, S. (1994). Fully activating interactive TV: Creating a blended family. Technological Horizons in Education Journal, 22(3), 86-90.

This article describes a recent effort to increase interaction and communication between two classrooms linked with Interactive Television (ITV). The instructor lectured in one classroom and was linked via TV to the other, remote classroom. The designers of the course curriculum operated from six assumptions: (a) active learning is vital to the students' development, (b) no sacrifice in learning should occur to incorporate the new technology, (c) learning is both cognitively- and emotionally-based, (d) giving students more responsibility yields more learning, (e) instructors need to be open-minded when designing a course for interactivity, and (f) learning can still occur if the TV link fails. A detailed description of the lesson plan and classroom reactions is given. A special effort was made to make the students at the remote site feel equal, important, and involved. Student workgroups were composed of students from both sites. "Four weeks into the term, students seemed comfortable working in groups, communicating cross-site and having what one student called 'public discussion.'" At the end of the term, students were asked to rate their experience. On average, students were impressed and enthusiastic.

15. Sandholtz, J. H., Ringstaff, C., & Dwyer, D. C. (1992). Teaching high-tech environments: Classroom management revisited. Journal of Educational Computing Research, 8,

The authors summarize findings from a five year collaboration between Apple Computers and 32 classrooms across the nation. Five of these classes were Apple Classrooms of Tomorrow (ACOT), which provided students with computers at home as well as in class. In addition, the ACOT classrooms were provided with a full supply of multimedia technology, not just computers. Three major findings are discussed: (a) classroom management is a dynamic challenge, not a one-time obstacle, (b) changes in educational practices take time, and (c) teacher change is polymorphous and inconsistent. The three stages of teacher adaptation to the technology focused on their concerns within each stage: survival, mastery, and student impact. Once the impact stage was reached, significant improvements in attitudes and performance were evident and the computers were viewed by the teacher as a success. Teachers began to realize that the computers could save them time rather than create additional demands. Teachers also described their classrooms as learner-centered, rather than teacher-centered or technology-centered. This final stage took more than a year to reach, however, suggesting that short-term evaluations may not provide a complete picture of technology's impact in the classroom.

16. Schofield, J. W., Eurich-Fulcer, R., & Britt, C. L. (1994). Teachers, computer tutors, and teaching: The artificially intelligent tutor as an agent for classroom change. American Educational Research Journal, 31(3), 579-607.

This article provides a good overview of the changing roles of students and teachers in the computer-assisted classroom. These changes cast the teachers as facilitators of learning instead of lecturing authority figures and cast the students as active learners rather than passive receivers of information. Thus, the computer may change the classroom social structure in several ways. The authors conducted a two-year analysis of computers in an urban high school classroom. The following observations were made: (a) the computer adds resources rather than replacing the teacher, (b) the teacher has more time to provide individualized instruction to needy students, (c) students are more in control of when, what type, and how much tutoring they receive, (d) help and assistance from both the computer and the teacher is more private, (e) the students engage in more peer interaction and friendly competition, (f) students can express anger toward the computer, which would violate strong social norms if focused toward the teacher, and (g) students spend more time on task. A paradox was also discovered: students prefer the teacher's help to the computer's help, but students prefer a computer-assisted

classroom over a traditional classroom. The authors explain this paradox with some of the above observations: the computer added to the classroom's resources (the computer taught the basic information), and the computer changed the social environment of the classroom (the computer increased the students' motivation), the teacher's assistance was more individualized (the teacher's assistance was not constrained by the needs of the rest of the class), and students had more control of the teacher's assistance (they could selectively receive answers from the computer or the instructor). The authors conclude: "...we would argue that in predicting or assessing the impact of technological innovations on the educational process, it is critical to go beyond a narrow focus on the intended subject-matter learning effects to a broader examination of how utilizing the software changed the content, process, and context of student learning....This study also points out the importance of recognizing that different kinds of computer applications may have quite different effects depending on differences in the applications themselves or the social context of their use."

17. Siegel, M. A., & Sousa, G. A. (1994, September). Inventing the virtual textbook: Changing the nature of schooling. Educational Technology, 34(7), 49-54.

According to the authors, the printed textbook is unable to fulfil its instructional goals. Instead, future computers with "virtual textbook" (VT) software would be better able to deliver instruction. The VT architecture attempts to link real-world problems with course content through problem-solving tools. "In the VT environment, the motivation for learning...derives from solving problems that are of intrinsic interest to the students." As conceptualization of the VT progressed, it evolved from a software product to a classroom environment. In the traditional model, school is a place where information is received, memorized, and repeated. In the new model with the VT, students learn a set of skills and strategies with which they can solve real-world problems; specific information is accessed and learned depending upon the current problem. The new classroom environment created by the VT has three components: (a) the VT itself, which is described as a portable information and work device, (b) an electronic chalkboard, which allows the transfer of information among students and serves as a community workspace, and (c) a multimedia server, which provides a centralized source of information from outside the school. The authors conclude that VT technology "...provides the students of the future with the power to become effective and creative learners."

18. Stoddart, T., & Niederhauser, D. (1993). Technology and educational change. Computers in the Schools, 9(2/3), 5-22.

The authors argue that computer-based Integrated Learning Systems (ILSs, drill-and-practice systems) are still based upon conservative ideas and will not initialize enough change in schools for computers to reach their full potential. Instead, the authors argue that tool-based systems (TBSs) which view the educational environment as learner-centered, should be incorporated. The philosophical foundation of ILSs is behaviorism, but the foundation of TBSs is cognitive psychology. Barriers to this proposed educational change include the difficulty of altering the status quo, teacher-independent core curricula, a lack of new technology training for teachers, and misallocation of money toward technology acquisition without teacher training, upgrades, and technical support. The authors conclude: "...we must begin to think in terms of the most productive ways to help students develop conceptual understandings."

19. Waddick, J. (1994). Case study: The creation of a computer learning environment as an alternative to traditional lecturing methods in chemistry. Educational and Training Technology International, 31, 98-103.

The use of computer-assisted learning (CAL) in a college-level chemistry class is described and discussed. The basic struggle is to prevent the computer from totally controlling the lesson and replacing the instructor, while also ensuring that it does not become an electronic page-turner. This research validated previous research, which has found that the following factors are significant in the incorporation of computers in the classroom: relevance to learning objectives, hardware and software considerations, the teacher's own philosophy, and the physical classroom arrangement. The benefits of CAL include: students are self-paced, students receive immediate feedback, the teacher has more individual time with students, students spend less time waiting for assistance, student co-operation is increased, course content is consistent, weaker or absent students can catch-up easier, and a more relaxed classroom atmosphere is created. Student evaluations of CAL were very positive, especially with regards to the self-paced instruction and immediate feedback. Older students more familiar with traditional formal classrooms felt less comfortable in the less structured environment. When compared to previous, non-computerized chemistry classes, student test scores increased by 20% after the incorporation of CAL.



20. West, G. R. (1994). Teaching and learning adaptations in the use of interactive compressed video. Technological Horizons in Education Journal, 21(9), 71-73.

Human reactions and adaptations to a distance learning system used by the University of Kentucky are examined. In particular, the University of Kentucky is using interactive compressed video (ICV), which, compared to normal video, creates jerky motion, a short time delay, and some loss of resolution. The ICV, however, allows two-way visual and auditory communication, thus allowing videoteleconferencing among two or more sites. The ICV signal is digitized and compressed by a personal computer before being transmitted. Certain aspects of the classroom are also computerized--when students speak into a microphone, video cameras are automatically switched to show that person. Adaptations made by the instructor include familiarization with the equipment, understanding students at remote locations without receiving their subtle body language and facial expressions (due to the poor visual quality of the transmitted image), remembering to keep students at all locations actively involved in the learning process, and acting as a conflict manager and team builder across remote sites. Adaptations made by students include consideration of the opinions expressed at other remote sites, and overcoming the desire of students at the originating site to not share the instructor with the remote sites. The author concludes that, as technology improves, many of the current problems will be eliminated. However, even in the system's current state, distance learning is a valuable learning medium.

21. Wiske, M. S., Zodhiates, P., Wilson, B., Gordon, M., Harvey, W., Krensky, L., Lord, B., Watt, M., & Williams, K. (1988). How technology affects teaching (ETC-TR87-10). Cambridge, MA: Educational Technology Center. (ED 296 706)

The authors performed a phone survey of 76 teachers to examine teacher attitudes and uses of computers in the classroom. Survey responses were compiled into seven composite personalities: (a) a teacher that has decided not to use computers, (b) a teacher looking forward to teaching with computers (but has not done so yet), (c) a teacher using computers in an elementary classroom, (d) a teacher using computers in special education, (e) a teacher responsible for teaching computer science and computer literacy, (f) a teacher responsible for integrating computers into the secondary math curriculum, and (g) a teacher responsible for training and supporting other teachers. "A clear message from this study is that the impact of computer technology on teachers cannot be considered narrowly but must acknowledge a wide range of

technologies, teachers, and school contexts." The discussion focused on how teachers use computers (either as an object to be studied, or as a tool to teach other subject areas), factors that influence teachers' use of technology (knowledge of computers, and incentives to use the computer in the classroom), access to resources and support, the impact of external mandates, the effects of new technology on teachers, the importance of synchronization between computers and class curriculum (adapting the computer to the teachers' existing teaching style or vice versa), the importance of teaching style and classroom social organization, technology's impact on classroom management, and teachers' roles as professionals. Other issues include ensuring adequate teacher training, improving resource availability, and adaptation of policy issues for computer use. Many teachers wished for more research on the effects of computerized teaching and learning.

Table 2

Recommended Training Techniques from Education Articles

| Education Reviews             | Training Techniques     |                   |                    |            |                     |            |                      |                 |
|-------------------------------|-------------------------|-------------------|--------------------|------------|---------------------|------------|----------------------|-----------------|
|                               | Computer-Based Training | Distance Learning | Local Area Network | Multimedia | Self-Paced Training | Simulation | Traditional Training | Virtual Reality |
| Armstrong, 1991               | +                       |                   |                    |            |                     | +          |                      |                 |
| Auld & Pantelidis, 1994       |                         |                   |                    |            |                     |            |                      | +               |
| Ball & Cook, 1994             |                         | +                 |                    |            |                     |            |                      |                 |
| Collins & Bostock, 1994       |                         | +                 |                    |            |                     |            |                      |                 |
| Cook & Kazlauskas, 1993       | +                       |                   |                    |            |                     |            |                      |                 |
| Farrington & Eeley, 1994      |                         |                   | +                  |            |                     |            |                      |                 |
| Hapeshi & Jones, 1992         | +                       |                   |                    | +          |                     |            |                      |                 |
| Jones & Kember, 1994          |                         |                   |                    |            | +/-                 |            |                      |                 |
| Klemm & Snell, 1994           | +                       | +                 |                    |            |                     |            |                      |                 |
| McLellan, 1993                |                         |                   |                    |            |                     |            |                      | +               |
| Mills, 1994                   | +                       |                   |                    | +          |                     |            |                      |                 |
| Rutherford & Grana, 1994      |                         | +                 |                    |            |                     |            |                      |                 |
| Sandholtz, et al., 1992       | +                       |                   |                    | +          |                     |            |                      |                 |
| Schofield et al., 1994        | +                       |                   |                    |            |                     |            |                      |                 |
| Siegel & Sousa, 1994          | +                       |                   |                    | +          |                     |            | -                    |                 |
| Stoddart & Niederhauser, 1993 | +                       |                   |                    |            |                     |            |                      |                 |
| Waddick, 1994                 | +                       |                   |                    |            |                     |            |                      |                 |
| West, 1994                    |                         | +                 |                    |            |                     |            |                      |                 |

Note: (+) = positive factor  
 (-) = negative factor  
 (+/-) = both positive and negative  
 ( ) = no opinion given/not discussed

## Appendix C

### Annotated Bibliography of Business Articles

1. Adams, D. L. (1994, Fall). CD-i and training: A perfect fit? Journal of Interactive Instruction Development, 7(2), 23-28.

Compact Disc-interactive (CD-i) is a compact disc-read-only memory (CD-ROM) based information delivery system. These CD-i players connect to conventional televisions (just like a videotape player), thus providing a low-cost training media. The advantages and disadvantages of CD-i with respect to courseware development and delivery are discussed. Advantages for delivery include: (a) low-cost hardware, (b) multiple audio channels for soundtracks and multiple languages, (c) keyboards, mice, printers, and floppy drives can be connected to the CD-i player, and (d) CD-i players can be networked. However, the disadvantages for delivery are that the CD-i hardware is proprietary and full-motion/full-screen video is an additional option. Development of CD-i-based courseware is convenient because it can be created on a computer and converted to the CD-i format, and there are no licensing fees for use of the player or authoring systems. However, disadvantages for development are that some authoring packages are complex and expensive, and the choice of authoring systems is limited. Professional, home, and portable CD-i players are available. The estimated cost for developing a CD-i course is \$21,000.

A case study of CD-i training at Kentucky Fried Chicken (KFC) is presented. A training program was developed to teach new employees basic store operations, food preparation, etc. Kentucky Fried Chicken invested \$120,000 and six months in the development of the 3 to 4 hour training program. A final test is included at the end of the training program. Student scores are recorded on diskette for later analysis. KFC has judged the CD-i training system a success and is now developing additional training programs. Other companies using CD-i trainers include PepsiCo, Chrysler Motors, Sikorsky, and federal agencies. The authors conclude: "With CD-i, all of the benefits of using a multimedia approach in training can be obtained, without experiencing the disadvantages of using a multimedia computer."

2. Albright, R. C., & Post, P. E. (1993, August). The challenges of electronic learning. Training & Development, 47(8), 27-29.

The authors discuss the changes in training that are the result of self-paced computer learning systems. The new

emphasis in training is away from instructor-led classrooms and toward individually-paced electronic performance support systems (PSSs). These new changes present many challenges to training designers. Of particular concern is the tradeoff between user and trainer control of the instructional process. Suggestions for the optimal configuration are: know the student population, allow student control only when it improves instruction, explain to trainees how to use learner control wisely, and allow trainers to control what is learned while students control how it is learned. Another issue is designing instruction to account for the four main ways of learning: reflectively, conceptually, practically, and creatively. PSSs are being used to increase productivity because they emphasize problem solving abilities and skills, not just increasing general knowledge. Another advantage of PSSs is that they are available from any location via computer access, so they are classroom independent. Examples of PSS use at Steelcase and IBM are included.

3. Campbell, R, & Monson, D. (1994, November/December). Building a goal-based scenario learning environment. Educational Technology, 34(9), 9-14.

A thorough analysis of in-house training methods led to the conclusion that traditional classroom-based learning methods could not meet Andersen Consulting's training needs. Instead, Andersen has looked to goal-based scenario (GBS) training. The GBS training engages students in active problem solving by presenting students with goals that must be achieved. Skills and knowledge needed to reach the goal are learned during the process of goal attainment. The goal often includes real-world tasks, teamwork, human coaches (rather than lecturers), and computer-based on-line reference materials. The construction of a GBS training course is described as an iterative process composed of five steps per iteration. A detailed description of the development and use of a prototype multimedia GBS training course is included. In summary, the authors conclude, "It is clear to us that GBS learning environments not only teach identifiable skills, but also foster growth in communications, human relations, and problem solving. Participation in GBS activities is part of the maturation of individuals, helping them to become more knowledgeable, productive, resourceful, and creative employees in the workplace."

4. Cavanagh, J. (1993, June 14). Firms share their TBT success stories. Network World, 10, 32-33.

This article examines how several companies are utilizing technology-based training (TBT) and the benefits they are

receiving. Technology-based training (also known as computer-based training (CBT)) allows more employees to be trained for the same amount of money as traditional training methods because it reduces or eliminates travel, lodging, and time-away-from-work costs. Currently, TBT is being used during three phases of training. It is initially used before formal training as a way to create a base level of knowledge and experience. Some companies are using TBT during formal training, either as supplemental material to traditional classroom material or as a replacement of classroom material. In addition, TBT is used as a post-training refresher course that can be summoned at any time from the employee's work computer. The authors conclude that "...TBT allows more in-depth training with greater retention than static material in books and manuals. TBT can be used with minimum disruption to the typical work schedule and without travel time or expenses."

5. Dublin, L. E. (1993, August 30). Learn while you work. Computerworld, 27, 81-82.

"The world is changing too fast to make memorization the primary way people learn and improve their job performance." The author argues that integrated performance support systems (IPSSs) are the ideal way to help workers adapt to the changing world. The advantage of IPSSs is that they are user-oriented support systems that provide just-in-time training--workers learn information when it is applicable to the task at hand. The IPSSs consist of four components: (a) technology--computer-based training, on-line help, on-line bulletin boards, and knowledge-based systems; (b) media--video and audio tapes and interactive video discs; (c) print--training manuals, pamphlets, instructional materials, and books; and (d) people--instructor-led training, help desk hot lines, and consultants. Although IPSSs are very flexible and can be composed of any combination of these materials, "...the system *must* provide information, advice, and learning when it's needed, where it's needed, and in the medium most effective for the user." [emphasis in original] A case study of a San Francisco-based insurance company is presented. During an effort to improve customer support, the company realized that it would take four years and cost tens of millions of dollars to retrain all of its employees with traditional training methods. By using an IPSS instead, the company retrained all of its employees in 18 months at less than half the cost of the traditional training. Perhaps most importantly, the use of IPSSs reduced the amount of time employees were away from their jobs, thus maximizing productive work during retraining.

6. F., B. (1994, October). Ford does distance learning by the numbers. Training, 31, 97.

Ford Motor Co. has committed \$100 million to the development of the satellite-based Fordstar Distance Learning Network. The network will be used to train auto mechanics in the 6,000 dealerships across the nation by 1996. Ford determined that this system would cost less than having the mechanics travel to regional training centers. The network will deliver live, instructor-led classes with one-way video and two-way voice communication. While students watch the training programs, they will be able to answer the instructor's questions by pressing a keypad. These responses will be sent to the instructor, who can then assess the class progress and adjust the lesson as necessary. The instructor will also be able to single-out (either specifically or randomly) any student and to ask specific questions. A preliminary evaluation of the system was conducted with Wayne State University students. In this initial evaluation, instructional time was decreased by 20% and test scores increased by 18%.

7. G., H. (1994, December). Interactive software teachers changing computing. Computer Shopper, 58, 68.

Describes the recent trend among PC software companies of adding "coaches," "wizards," and "pilots" to further enhance the help features of their programs. These on-line help systems offer real-time, context-sensitive assistance, allowing users to walk step-by-step through complex procedures. Often, these tutorials can allow the user to practice a function as a simulated task on sample data or text before attempting to perform the task with real data or text. In addition, these tutors can explain the user's error, correct the error, and teach the user how to avoid the problem in the future. WordPerfect is reportedly working to incorporate speech-based tutors in future versions of its software. Other future software, such as Apple's next operating system, promises to anticipate the user's needs. These intelligent tutors allow software vendors to reduce telephone support costs. They also reduce training costs for the businesses that purchase the software, because the software now includes its own tutorial and expert.

8. Galagan, P. (1994, March). The instructional designer in a new age. Training & Development, 48(3), 52-53.

This article is an interview with a Microsoft program developer about an electronic performance support system called Cue Cards. Cue Cards provide flexible, context-sensitive assistance to the user while the user is working



instead of interrupting work and switching to a tutorial mode. This allows the user to continue completing the current task without distraction because only the information needed to complete the current task is given. Later, the user can run a tutorial for more in-depth instruction about a specific feature of the program. Cue Cards are now incorporated into several Microsoft programs.

9. Geber, B. (1994, May). Re-engineering the training department. Training, 31(5), 27-34.

Discusses the re-engineering of in-house corporate training departments. Re-engineering typically focuses on changing the delivery of instructional information, although it can be extended to the functions of the training department itself. Many high-tech companies with widely scattered employees are now using distributed training, in which computer-based instructional information is provided at the trainee's desk as the need arises (AKA just-in-time training), rather than in a centralized, structured classroom setting. The idea of distributed training is not new, but only recently has technology finally developed to the point of being able to realize the concept. Distributed training eliminates costly (both time and money) travel to centralized training classrooms. Two major obstacles to re-engineering are discussed. The first is technology-based: the technology may not yet exist for full realization of the idea or the technology may be too expensive. In addition, the learner can also present obstacles. Often, students feel more comfortable in the traditional classroom setting--they prefer having another person to speak with. Many corporate examples are included, including Hewlett-Packard, Andersen Consulting, U.S. West, Symmetrix, Northern Telecom, Federal Express, Apple Computers, and AT&T. Most of these companies, however, "...tend to be high-tech or communications firms, whose employees are already comfortable using sophisticated technology." Incorporating these changes in companies that are not computer literate is a major challenge. "It's just possible that 15 years from now...a tiny fraction of instruction will be delivered in classrooms, and everyone in the training community will look back in wonder at the marvelous inefficiency of the system that exists today."

10. Gonzalez, R. (1991, July/August). Training: New technologies, new needs. Datacenter Manager, 3, 18-19.

"The focus of American business today is on utilizing information system technology to the fullest in order to raise productivity and enhance system quality." However, an increased reliance upon high technology to produce this improved productivity also increases the need for highly-

trained personnel. The major reason new systems fail is an inadequately-trained user (or users). Due to increasing system complexity, the author argues that computer training is now mandatory, not optional. Low-cost training strategies for a variety of trainee group sizes is suggested. Sending students to a central location for training is a good solution for one to three employees. For larger groups (at least six), it is more cost effective to send the instructor to the students. However, traditional instructor-led training is not the only (or necessarily best) option available. Computer-based training (CBT) and interactive video instruction (IVI) are both suitable for technical training. Satellite-transmitted courses, which combine "...the benefits of instructor-led teaching with the convenience of direct transmission to a client site," are also suggested as effective options with enormous potential. Satellite-transmitted courses usually have two-way audio and video, allowing natural communication between instructor and student. These courses can be scheduled for short periods each week, thus allowing training while not significantly reducing non-work time. This scheduling option also allows students to apply new knowledge in the work environment and return to the classroom with questions. Many effective training methods and technologies are available--the biggest challenge is matching the training needs to the available systems.

11. Heathman, D. J., & Kleiner, B. H. (1991, September). Training & technology: The future is now. Training & Development, 45(9), 49-54.

"Today's employees need more basic training than employees did in the past, and technology is an efficient way to teach this basic information." Several large companies have now included computer-based training (CBT) as part of their overall training solution. The authors argue that CBT should not replace all other forms of training, but rather should serve to complement existing training methodologies. The potential benefits of CBT programs are seen as maximizing training time at a reduced cost. Future applications of CBT will include telecommunications, artificial intelligence, soft skills training, and performance support systems. Barriers to full acceptance of CBT are the development time of courseware, the cost of the design and development of courseware, and the lack of human interaction when using CBT. Computer-based training is seen as one piece of the total training solution: "...the point is to use computer-aided training in response to a need, not to try to fit all training solutions into one instructional method."

An example of CBT in the work place is Federal Express. Their new package-tracking system has an embedded training module that constantly monitors the employee's performance. When errors are detected by the system, the system provides the appropriate help. With the incorporation of this and other CBT systems, Federal Express has reduced travel costs for training classes, improved error rates on the job, reduced time away from the job for training, and realized a ten-percent improvement in productivity and quality. Federal Express is saving over \$150 million per year when compared to equivalent traditional training costs. Another example is provided by Ford Motor Company. Ford's service technicians now train with a self-paced training system located at each dealership. The CBT system provides the majority of training, then technicians travel to regional training centers for final certification.

12. Hequet, M. (1994, May). Should every worker have a line in the information stream? Training, 99-102.

Electronic performance support (EPS) systems are on-line reference systems that workers can access while working on their computers. Thus, EPS systems can provide training in the workplace while the employee is using the problem task or software application. Successful examples of EPS use from Deloitte & Touche, AT&T, Aetna, U.S. West, and other companies are included. However, although EPS systems are extremely powerful, it is generally believed that they cannot fully replace human trainers. Tips for EPS system development and use include: (a) make the software as simple as possible, if it is too difficult, people will use a book or manual instead, thus defeating the purpose of the EPS system, (b) younger employees adapt to EPS faster, (c) EPS software has high processing and memory demands, so older computers may not be able to run it effectively, and (d) users are usually unable to print from EPS programs because the information is updated frequently. A potential danger of extensive EPS use is that employees will no longer think on their feet or be creative, since the system only teaches task-specific procedures, not generalized problem-solving strategies. In addition, just-in-time training seems to counter the prudent idea of just-in-case learning. "Do we want workers who have fast, ready-made answers, or workers who can think?"

13. Kemske, F., & Weingarten, N. J. (1990, March). A memo from the future: Data training in 1999. Information Executive, 3, 27-29.

The authors conducted a survey to collect "expert" predictions of training technology and techniques in 1999. Their views are given for each of the following categories:

(a) training and education--training expenditures will increase, most training will be delivered through technology, technically and scientifically trained persons will be in high demand, public education will not produce well-trained people, and software will be produced with embedded training; (b) organizations--organizations will decentralize and become more complex, companies will be leaner with fewer hierarchical levels, and corporations will become result- and performance-oriented; (c) the economy--business will be global, inflation and taxes will rise, retirees will rejoin the workforce and need retraining, and there will be international competition for well-trained employees; (d) society--two-income families will be normal, the number of temporary and part-time workers will increase, the age of the workforce will increase, workers will make more career changes at any age, the rift between the upper and lower classes will enlarge, and telecommuting from home will be common; and (e) technology--software will adapt to its user, computer networking will improve, standards will be more common, and software will have built-in assistance. Basically, the experts foresee a shortage of well-trained personnel due to poor public schools, thus placing the burden of training upon employers. In general, problems will become more diverse and complex, thus making training an increasingly important component of a business' activities.

14. Koch, K. W., & McConnell, V. C. (1992, January/February). The death of training; The rebirth of the trainer. Data Training, 11, 30-33.

According to the authors, constant innovations in technology and rapid expansion of computer use are forcing many to reconsider the role of training. Paradigm shifts are occurring in many aspects of training: (a) presentation style--from traditional classroom lectures to facilitation and mentoring, (b) trainer's knowledge base--from knowing how a complex system operates to knowing how to apply the complex system to the business' needs, (c) assumption underlying the trainer's work--from being knowledgeable in technology to understanding how to combine people and technology to perform problem-solving tasks, (d) direction provided to the trainer--from training previously selected technology to being involved in the technology selection process, (e) level of trainer's impact--from solving problems with machine use to improving overall task performance, and (f) trainer's ultimate goal--from teaching users how to operate technology to developing creative use of technology and worker skill to achieve goals. In effect, the trainer is becoming the link between management and the workforce. The authors encourage trainers to explain the

benefits of these paradigm shifts to their management, so these changes can take place in their company, too.

15. Ladd, C. (1993, August). Should performance support be in your computer? Training & Development, 47(8), 22-24.

Electronic Performance Support (EPS) systems offer computer-based assistance from within software applications during task performance. The EPS systems attempt to combine the benefits of three typical on-the-job information sources: asking a co-worker (which involves interrupting his/her work and may result in an inaccurate answer), looking-up the information in a manual (which is time consuming), and taking a seminar or training class (which is expensive and time consuming). In other words, an EPS system typically is composed of an advisor/expert, on-line references, and computer-based training. "Electronic performance support probably will never completely replace more traditional training options. But the technology does have several advantages." These advantages include: on-the-job instruction (EPS can act as a reminder after traditional classroom instruction), low long-term cost, and flexibility. EPS is "...particularly useful in situations in which the workforce is diverse, multiple skills are required to do a job, and job-skill requirements continually change." The need for EPS depends upon the internal business environment and the needs of the employees. Factors in the business environment that may necessitate EPS are: training budget is shrinking, organization is downsizing, quality must be improved, productivity must be improved, new software is being installed, employees are in various locations, employees use computers to work, and high employee turnover. Employee-related factors that may indicate a need for EPS are: various skill levels are required to perform tasks, employees have diverse learning styles, employees need access to experts, retention is poor after existing training, employees must learn while continuing to work, and job-related information must be referenced during work.

16. Leinfuss, E. (1993, January 25). Training in the age of downsizing. Computerworld, 27, 77.

On-the-job training led by in-house experts is an economical way to train skill and knowledge during periods of financial difficulties. Instead of sending all employees to intensive (and expensive) training seminars, companies are now sending a few people to these seminars who then become the in-house experts and teach other workers through informal interaction or organized classes and lectures. The author argues that "...it is economical and effective to rely on peer experts to share their knowledge through on-the-job training." Some organizations have developed a mentor system in which a

junior employee is assigned to a senior employee. The junior employee can contact the senior employee as questions arise, thus receiving answers on an informal basis. Providing a library of self-paced multimedia training materials is also mentioned as an alternative to formalized training. With such a library, employees can "check-out" training videotapes and other materials to review at home, thus preventing training from interrupting work hours.

17. Lierman, B. (1994, February). How to develop a training simulation. Training & Development, 48(2), 50-52.

A simulation is a realistic, safe, and controlled environment in which students can learn through hands-on, real-world experiences. When developed correctly, "...a simulator mimics the controls, methods, and consequences of actions performed by operators." Simulations can be classified into four types depending on what aspect of the real environment is simulated. Psychomotor and perceptual simulations duplicate the physical aspects of a task. Simulations of cognitive tasks focus on the mental aspects of a task. In communication and coordination simulators, students typically serve as one component of a team and must perform a task through teamwork and communication. Finally, virtual reality has recently emerged as a new technology capable of total sensory simulation.

Deciding if simulation is the appropriate training method for a particular need requires the consideration of several factors. Simulation is typically not suited to short-term training needs because of the high cost of its development. The number and composition of people to be trained is also a factor. The types of skills that will be trained are also an issue. "Typically, simulations are more cost-effective in training for skills and attitude changes than in training for knowledge." The fidelity or realism with which the task(s) will be simulated must be determined. Higher fidelity usually means higher costs. Perhaps the most expensive aspect of fidelity is the amount of interactivity between the student and simulator. Once simulation has been selected as the appropriate training mode, several steps must be taken to ensure a good training program. The interactivity between the student and systems must be diagrammed in high detail. This can take place in two steps, one that specifies the simulator's modes and one that specifies the controls available to the student within each mode. The medium of the simulation must also be determined. There are two basic types of simulation models, static (usually paper-based) and dynamic (usually computer-based).

The authors conclude that if the simulation is well-matched to the task and properly designed and used, significant

improvements in training will be observed. The time needed to train to proficiency can be reduced by as much as 85%. "People trained in simulated environments that closely resemble their actual work environments tend to experience a high rate of transfer of training to their jobs."

18. Montgomery, J., Campbell, R., & Moffett, C. (1994, November/December). Conducting and supporting a goal-based scenario learning environment. Educational Technology, 34(9), 15-20.

This article describes recent changes at Andersen Consulting's Center for Professional Education in St. Charles, Illinois. Andersen has moved from a traditional lecture-based teaching environment to a goal-based scenario (GBS) learning environment. In the GBS learning environment, "...learners build target skills through participating in a simulated work environment..." rather than through lectures. Therefore, the GBS paradigm is learning-focused, not teaching-focus. Students are grouped into project teams and assigned real-world problems to solve. Instructors serve as coaches who assist the project teams. As each of Andersen Consulting's training centers is converted to the GBS method, experts train the coaches. The daily schedule of a typical GBS course is described as very busy and long. Lessons learned from a year of GBS use include: both learners and instructors must make significant changes in the GBS learning environment, students in the project teams must have good inter-team communication, and allowing more time to complete tasks will lead to greater student creativity. The authors conclude that GBSS are a success because: (a) they feel natural to participants, (b) they allow students to learn at their own pace and in their preferred method, and (c) they can be altered easily to teach new material.

19. Nowakowski, A. (1994, November/December). Goal-based scenarios: A new approach to professional education: Reengineering education at Andersen Consulting. Educational Technology, 34(9), 3-8.

Efforts at Andersen Consulting to improve employee training are examined. First, several critical training and educational requirements were identified. It was then determined that these requirements could not be met with traditional instructor-led, classroom-based instruction (their previous method) due to the size of the company (20,000 employees in 151 offices in 46 countries). Andersen then looked to goal-based scenarios (GBS). "A GBS approach to learning is based on the principle that the best way to learn is through experience, or learning-by-doing." For



instance, instead of attending a lecture on the development of software, the students develop software. In the process, the students learn problem-solving procedures and acquire relevant knowledge. To some extent, GBSs are simulations of the task to be learned. A computer-based, interactive, self-paced training program was developed that uses the GBS approach. The use of computer-based technology was employed primarily to provide consistency. The resulting course led to a total cost-savings of \$10.5 million per year. If the results of a current proof-of-principle project are positive (as expected), Andersen plans to convert many of their classroom-based courses to the GBS format. (For more information, see Campbell and Monson, 1994)

20. Oz, E., & White, L. D. (1993). Multimedia for better training. Journal of Systems Management, 44(5), 34-38, 43.

Multimedia combines the audio and video of television with the flexibility and artificial intelligence of a computer. "By engaging in multi-sensational methods of communication, people are more apt to become involved than in traditional training methods. The involvement enhances their ability to retain information." Multimedia is primarily used in business, industry, training, education, and merchandizing. The authors polled six diverse organizations (IBM, EDS, Bethlehem Steel, Federal Express, Ford Motor Credit, and a large defense contractor) in an attempt to determine if the potential benefits of multimedia are being realized. The primary advantages of multimedia-based training were found to be: reduced travel time and cost, self-paced instruction, reduced costs for training, private and immediate feedback, consistent training, and reduced training time. Some secondary benefits were also mentioned, including improved employee moral and lower employee turn-over rates. The principal disadvantages were: high cost of initial courseware development, training must be performed during work time, difficult to update all training stations when they are not networked, courseware requires large amounts of computer memory, and high cost of updating the courseware. Most companies utilize a pre-/post-test format for their training programs. The authors conclude: "...although the initial cost of a multimedia training systems [sic] is significantly higher than the development of classroom training, the benefits far outweigh the costs."

21. Piskurich, G. M. (1993, March). The possible future(s) of instructional technology. Training & Development, 47(3), 51-53.

The author provides a general discussion of technological and methodological advances possible in the next century and their impact upon training technology and trainers. These

possibilities were compiled from the predictions of training experts. Computers are expected to continually advance in complexity, power, and usefulness while their cost continues to fall. "In the 21st century we will see artificial intelligence become a major training technology." New interfaces such as speech recognition will improve human-computer interaction, thus improving the computer's usefulness. Computers will also become more commonplace, thus increasing the number of well-educated people in the population. This smarter population will lead to greater productivity and improved socio-political conditions. Training will be high-tech, diverse, effective, and fun through a better understanding of human learning and motivation. Trainers will be highly skilled and will specialize in specific aspects of training such as training tool development or training tool application. Training increasingly will rely on simulations and game-based training as businesses become more diverse and task-oriented. International business competition will also spur training research and development. No expert consensus was reached, however, on the overall philosophy of training in the future--experts did not know whether knowledge training or performance training would be the dominant training mode.

22. Piskurich, G. M. (1994, March). Developing self-directed learning. Training & Development, 48(3), 31-36.

Self-directed learning (SDL) is a training strategy that allows learners to work at their own pace, without an instructor, to master specific information. A successful SDL program must have four elements during development to prevent failure: a job analysis (a break-down of the tasks and skill required to perform a specific job), an implementation analysis (using SDL in either a centralized learning center or distributed throughout the organization), a format analysis (determining the media that will convey the lesson), and a facilitator analysis (choosing the personnel to run the training program). Several elements are important during the development of an SDL package: developing trainee-centered objectives, creating the training package's contents, arranging learning material into sections or "chunks," translating the learning material into the chosen format, developing post-training evaluation questions that relate to specific training objectives, and performing a pilot test of the SDL package. The SDL format may be the appropriate training device when: a large number of learners have diverse training needs, learners need individualized development, the same learning program must occur at several locations, training must be consistent for all students, and high turnover requires constant training of new employees.

23. Proctor, P. (1994, July 11). New Boeing training center to meet 777 crew demand. Aviation Week & Space Technology, 141, 36.

Boeing has recently completed construction of a new \$109-million, 600,000 sq ft, 700-employee Customer Services Training Center. The center provides training on all new and old Boeing transport planes for cockpit, flight, and maintenance crews. Much of the training is included in the sale of an aircraft. The training facility houses 41 fully-computerized classrooms, 18 fixed-base maintenance simulators, and several full-motion flight simulators. A primary concern during the design of the facility was the reduction of training time, which will reduce training-related expenses such as lodging. Air crews of the new 777 were being trained before construction of the first 777 was completed. The 777 courses were developed in-house by multi-disciplinary teams during the design of the 777 aircraft. The new 777 training courses are divided evenly between self-paced computer-based training and multimedia-based instructor-led lectures. As a result, training time has been reduced by 50% when compared to the 707 training courses. All courseware is stored on a central computer and down-loaded before each class, thus providing standardization and easy updates and upgrades. Students work alone during the self-paced training, but are grouped into teams during simulation training to enforce teamwork and resource management. Students are also provided with take home packages that include refresher courseware.

24. Rogers, R. C. (1994, November). Distance learning: It played well in Peoria. Training, 31, 51-54.

This article describes the development of a satellite-based, interactive training program. The program was an effort by Caterpillar, Inc., and PACCAR (the parent company of Kenworth and Peterbilt trucks) to provide salespersons with up-to-date, cost-effective customer service training. "The question has always been, how do we provide effective, up-to-date training without spending two or three years trying to get to everyone?" Satellite-based interactive communication was chosen as the alternative training solution. The satellite-based program was received and viewed at 80 dealer locations across the U.S.. Prior to the training session, a training needs analysis was performed to determine the program's content. The training consisted of three two-hour shows that included "before-and-after" video segments followed by viewer questions and discussion. The training program was judged a success. Students in the remote sites completed comment and suggestion forms, which the instructors analyzed and incorporated into future broadcasts.

25. Silber, K. H. (1990, August). How technology is changing training. Data Training, 9, 18-23.

The author believes there is a gap between theory and practice in the training world. However, technology is seen as being able to improve instructional design and training in the near future. This will occur in five main ways: (a) technology will force trainers to design training programs in systematic, logical sequences, (b) embedded, just-in-time training and performance assistance will become standard training methodologies, (c) the instructional design process will be automated by new software tools, (d) expert systems and instructional software will merge and become more widely distributed, and (e) training methodologies will become more diverse and creative and training content will focus more on higher-level learning, concepts, and heuristic learning. The author concludes by reminding training professionals that they determine future trends in training.

26. Sipior, J. C., & Townsend, J. (1993). A case study of General Electric's multimedia training systems. Information Resources Management Journal, 6(4), 23-31.

General Electric (GE), one of the top five government contractors in the U.S., recently developed a multimedia training system to teach 270,000 employees compliance with laws and regulations relevant to government contract work. The multimedia training system consists of 19 modules, which replaced a series of 19 seminars. "Although seminar participants were satisfied with the training sessions, it was recognized that there was a need to deliver information better in order to increase retention, promote better use of information, and foster the development of more capable employees." Each training module was developed in three phases: analysis, design, and implementation. This development process takes about 30 weeks for each training module. Due to the success of the training program, the multimedia format has now been applied to other training needs within the company. User satisfaction ratings of the training systems are high, but there is no mention of knowledge retention.

27. Spitz, C. (1992, June). Multimedia training at Hewlett-Packard. Training & Development, 46(6), 39-41.

The author describes customer training programs developed by Hewlett-Packard (HP) to meet customer requests for cheaper and quicker instruction. "At [HP], the need for some kind of CBT training became apparent when the company's customers began requesting alternatives to traditional classroom lectures." Several reasons were cited for this requested change: employees could not leave their jobs for several

days to attend training classes, employers did not want to pay the travel costs associated with training seminars, and some employees needed immediate training and could not wait for the next available training seminar. Compact Disc-Read-Only Memory (CD-ROM) was chosen to deliver the training due to its large storage capacity, convenience, and wide-spread availability in the U.S. The CD-ROM training system is "...a low-cost, multimedia, self-paced training program that's conducted in the customer's workplace." HP's CD-ROM-based CBT system relies mainly on audio, text, and simple animation; no full-motion video is included. Development time is significant, however, with 150 hours needed to develop one hour of instruction. Extensive usability testing was conducted with the aid of actual trainees. These usability tests led to a special installation sheet that helped trainees install the training software and begin the lesson. It was also discovered that trainees wanted a printed summary of the lessons for later review. The author concludes that "...unlocking CD-ROM technology can lead to cost-effective, usable technical training."

Table 3  
Recommended Training Techniques from Business Articles

| Business Reviews         | Training Techniques     |                   |                     |                     |                       |                       |            |                             |                     |            |                      |
|--------------------------|-------------------------|-------------------|---------------------|---------------------|-----------------------|-----------------------|------------|-----------------------------|---------------------|------------|----------------------|
|                          | Computer-Based Training | Distance Learning | Game-Based Training | Goal-Based Scenario | Just-in-Time Training | Just-in-Case Training | Multimedia | Performance Support Systems | Self-Paced Training | Simulation | Traditional Training |
| Adams, 1994              | +                       |                   |                     |                     |                       |                       | +          |                             |                     |            |                      |
| Albright & Post, 1993    |                         |                   |                     |                     |                       |                       |            | +                           | +                   |            |                      |
| Campbell & Monson, 1994  |                         |                   |                     | +                   |                       |                       | +          |                             |                     |            | -                    |
| Cavanagh, 1993           | +                       |                   |                     |                     |                       |                       |            |                             |                     |            |                      |
| Dublin, 1993             | +                       |                   |                     |                     | +                     |                       |            | +                           |                     |            |                      |
| F., 1994                 |                         | +                 |                     |                     |                       |                       |            |                             |                     |            |                      |
| G., 1994                 | +                       |                   |                     |                     |                       |                       |            |                             |                     |            |                      |
| Galagan, 1994            |                         |                   |                     |                     |                       |                       |            | +                           |                     |            |                      |
| Geber, 1994              | +                       |                   |                     |                     | +                     |                       |            |                             |                     |            |                      |
| Gonzalez, 1991           | +                       | +                 |                     |                     |                       |                       |            |                             |                     |            |                      |
| Heathman & Kleiner, 1991 | +                       |                   |                     |                     |                       |                       |            |                             |                     |            |                      |
| Hequet, 1994             |                         |                   |                     |                     | -                     | +                     |            | +                           |                     |            |                      |
| Ladd, 1993               |                         |                   |                     |                     |                       |                       |            | +                           |                     |            |                      |
| Leinfuss, 1993           |                         |                   |                     |                     |                       |                       | +          |                             |                     |            |                      |
| Lierman, 1994            |                         |                   |                     |                     |                       |                       |            |                             |                     | +          |                      |
| Montgomery et al., 1994  |                         |                   |                     | +                   |                       |                       |            |                             |                     |            |                      |
| Nowakowski, 1994         | +                       |                   |                     | +                   |                       |                       |            |                             |                     |            | -                    |
| Oz & White, 1993         | +                       |                   |                     |                     |                       |                       |            |                             |                     |            |                      |
| Piskurich, 1993          | +                       |                   | +                   |                     |                       |                       |            |                             |                     | +          |                      |
| Piskurich, 1994          |                         |                   |                     |                     |                       |                       |            |                             | +                   |            |                      |
| Proctor, 1994            | +                       |                   |                     |                     |                       |                       | +          |                             | +                   | +          |                      |
| Rogers, 1994             |                         | +                 |                     |                     |                       |                       |            |                             |                     |            |                      |
| Silber, 1990             |                         |                   |                     |                     | +                     |                       |            |                             |                     |            |                      |
| Sipior & Townsend, 1993  | +                       |                   |                     |                     |                       |                       | +          |                             |                     |            |                      |
| Spitz, 1992              | +                       |                   |                     |                     |                       |                       | +          |                             |                     |            |                      |

Note: (+) = positive factor      (-) = negative factor  
( ) = no opinion given/not discussed

## Appendix D

### Acronyms and Abbreviations

|                  |  |
|------------------|--|
| AAR . . . . .    | After Action Review  |
| ACOT . . . . .   | Apple Classrooms of Tomorrow                                 |
| ACTIVE . . . . . | Automotive Component Troubleshooting in a Visual Environment |
| AET . . . . .    | Armament and Electronic Trainer                              |
| AETC . . . . .   | Air Education Training Command                               |
| AFV . . . . .    | Armored Fighting Vehicle                                     |
| AKA . . . . .    | Also Known As  |
| AOT . . . . .    | Army Optimized Team  |
| APST . . . . .   | Aircraft Power Supply Trainer                                |
| ARI . . . . .    | U.S. Army Research Institute                                 |
| ARNG . . . . .   | Army National Guard  |
| ARO . . . . .    | U.S. Army Research Office                                    |
| ARPA . . . . .   | Advanced Research Projects Agency                            |
| AVCATT . . . . . | Aviation Combined Arms Tactical Trainer                      |
| AWE . . . . .    | Advanced Warfighter Experiment                               |
| BBS . . . . .    | Bulletin Board System  |
| CAI . . . . .    | Computer-Assisted Instruction                                |
| CAL . . . . .    | Computer-Assisted Learning                                   |
| CAST . . . . .   | Combined Arms Staff Trainer                                  |
| CATS . . . . .   | Combined Arms Training Strategy                              |
| CATT . . . . .   | Combined Arms Tactical Trainer                               |
| CAX . . . . .    | Computer-Assisted Exercise; Combined Arms Exercise           |
| CBI . . . . .    | Computer-Based Instruction                                   |
| CBT . . . . .    | Computer-Based Training                                      |
| CCTT . . . . .   | Close Combat Tactical Trainer                                |
| CD . . . . .     | Compact Disc   |
| CD-i . . . . .   | Compact Disc - Interactive                                   |
| CD-ROM . . . . . | Compact Disc - Read-Only Memory                              |
| CE . . . . .     | Concurrent Engineering                                       |
| CECOM . . . . .  | U.S. Army Communications and Electronics Command             |
| CITV . . . . .   | Commander's Independent Thermal Viewer                       |
| CPT . . . . .    | Cockpit Procedure Trainer                                    |
| CVCC . . . . .   | Combat Vehicle Command and Control                           |
| DCD . . . . .    | U.S. Army Director of Combat Developments                    |
| DIS . . . . .    | Distributed Interactive Simulation                           |
| DITS . . . . .   | Diagnostic Intelligent Tutoring System                       |
| DSS . . . . .    | Decision Support System                                      |
| E-mail . . . . . | Electronic Mail  |
| EPS . . . . .    | Electronic Performance Support                               |
| ERIC . . . . .   | Educational Resources Information Center                     |
| FA . . . . .     | Field Artillery  |
| FICS . . . . .   | Friendly Interface for Conferencing System                   |

|                   |   |
|-------------------|---|
| GARS . . . . .    | Generic Airborne Radar Maintenance Trainer    |
| GBS . . . . .     | Goal-Based Scenarios                          |
| GE . . . . .      | General Electric, Inc.                        |
|                   |   |
| HITT . . . . .    | High Transfer Training                        |
| HP . . . . .      | Hewlett-Packard                               |
|                   |   |
| IBM . . . . .     | International Business Machines, Inc.         |
| ICV . . . . .     | Interactive Compressed Video                  |
| ICW . . . . .     | Interactive Courseware                        |
| IET . . . . .     | Intelligent Embedded Trainer                  |
| IETM . . . . .    | Interactive Electronic Technical Manual       |
| IFSAS . . . . .   | Initial Fire Support Automated System         |
| ILS . . . . .     | Integrated Learning System                    |
| IMSS . . . . .    | Integrated Mission Support System             |
| IPSS . . . . .    | Integrated Performance Support System         |
| ISG . . . . .     | Interactive Study Guide                       |
| ITA . . . . .     | Intelligent Training Aid                      |
| ITV . . . . .     | Interactive Television                        |
| IVI . . . . .     | Interactive Video Instruction                 |
| IVIS . . . . .    | Intervehicular Information System             |
|                   |   |
| KEG . . . . .     | Knowledge Engineering Group                   |
| KFC . . . . .     | Kentucky Fried Chicken                        |
|                   |   |
| LAN . . . . .     | Local Area Network                            |
|                   |   |
| MFS . . . . .     | Manned Flight Simulator                       |
| MILCOM . . . . .  | Missile Command                               |
| MPT . . . . .     | Manpower, Personnel, and Training             |
|                   |   |
| NET . . . . .     | New Equipment Training                        |
| NTC . . . . .     | National Training Center                      |
| NTIS . . . . .    | National Technical Information Service        |
|                   |   |
| OPFOR . . . . .   | Opposing Forces                               |
|                   |   |
| POSNAV . . . . .  | Position Navigation                           |
| PSS . . . . .     | Performance Support System                    |
| PTT . . . . .     | Part-Task Trainer                             |
|                   |   |
| RAF . . . . .     | Royal Air Force                               |
| RC . . . . .      | Reserve Component                             |
| R&D . . . . .     | Research and Development                      |
| RSC . . . . .     | Radar System Controller                       |
|                   |   |
| SAT . . . . .     | Systems Approach to Training                  |
| SDL . . . . .     | Self-Directed Learning                        |
| SIMITAR . . . . . | Simulation in Training for Advanced Readiness |
| SIMNET . . . . .  | Simulation Network                            |
| SOP . . . . .     | Standing Operating Procedure                  |
| SPQ . . . . .     | Study Process Questionnaire                   |



|                |   |
|----------------|---|
| STOWE . . . .  | Synthetic Theater of War - Europe                         |
| STRICOM . . .  | U.S. Army Simulation Training and Instrumentation Command |
| TBS . . . . .  | Tool-Based System   |
| TBT . . . . .  | Technology-Based Training                                 |
| TED . . . . .  | Turbine Engine Diagnostics                                |
| TQM . . . . .  | Total Quality Management                                  |
| TRADAP . . . . | Training Research and Development Action Plan             |
| TRADOC . . . . | U.S. Army Training and Doctrine Command                   |
| TTP . . . . .  | Tactics, Techniques, and Procedures                       |
| VR . . . . .   | Virtual Reality   |
| VT . . . . .   | Virtual Textbook  |
| VTT . . . . .  | Video Teletraining  |
| WAN . . . . .  | Wide Area Network   |

## Appendix E

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